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UNITED STATES DEPARTMENT OF AGRICULTURE
BULLETIN No. 846
Contribution from the Bureau of Chemistry
CARL L. ALSBERG, Chief

Washington, D. C. PROFESSIONAL PAPER June 5. 1920

EXAMINATION OF FROZEN EGG PRODUCTS AND INTERPRETATION OF RESULTS

By

H. W. REDFIELD

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By H. W. Redfield[1]

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OBJECT OF INVESTIGATION.

The preparation of frozen egg products is universally recognized as an excellent means of conserving eggs which can not be sold in the shell as a first-grade product. So extensive has the business become that 19,286,396 pounds of this material were held in storage on January 1, 1920. Careful studies of frozen egg products, by M. E. Pennington and her colleagues,[2] have included studies of the character of the raw material, the equipment and operation of breaking rooms, and the quality of the product sent into commerce. As a result there has been a marked improvement in the selection of the raw materials used and of the processes of manufacture, with a consequent improvement in the quality of the finished products. The examination of these products has been attended with what was suspected of being a disparity of results when material of the same quality was analyzed in different laboratories. The present investigation was undertaken in order to critically study these methods, and to ascertain whether they might be so standardized as to give concordant results when a number of analysts examined the same product simultaneously. A further object was to learn whether the results of the standardized methods would truly reflect the known quality of carefully prepared samples.

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[1] The investigation discussed in this bulletin was conducted by the author with the assistance of the following members of the Bureau of Chemistry: M. K. Jenkins, E. A. Read, J. H. Bornmann, G. G. De Bord, W. F. Duncan, L. D. Elliott, H. W. Houghton, W. R. North, G. C. Swan, and H. B. Switzer.

[2] U. S. Dept. Agr., Bur. Chem. Circ. 98 (1912); U. S. Dept. Agr. Buls. 51 (1914), 224 (1916), 39 (1918), 663 (1918).

PLAN OF INVESTIGATION.

Since the great bulk of frozen egg products is prepared in the Middle West, it seemed advisable to have the samples prepared in that section. Moreover, it appeared that valuable information could be obtained by preparing samples in different geographical locations, as Michigan or Minnesota, where the eggs while in the shell would have been transported and held under fairly cool climatic conditions, Illinois or Indiana, where the climatic conditions would be somewhat less favorable, and Kansas or Missouri, where the weather would be hot. It was planned to ship these samples for examination to a central point where all the analysts were assembled, in order to eliminate as completely as possible all variable factors. Difficulties in transportation in 1917 made it doubtful as to whether frozen egg samples shipped from a distance would arrive in proper condition for analysis at a central point. For this reason a trip was made to egg-breaking plants in the States named, to ascertain whether eggs were reaching any one large concentrating and breaking center from the same general sources of supply as those used in the other locations, and to learn whether railroad transportation of samples could be depended upon. It was found that shipping frozen egg samples in small lots from outlying points to any central location would be a precarious undertaking and inadvisable. It was found also that in one concentrating center eggs were being received constantly from all of the important producing States, in many instances after long railroad hauls. For that reason, those in charge of the investigation decided to prepare the samples in August, when eggs are recognized as being of the poorest quality, in this concentrating center where checks, dirties, and current receipts were being received from distant points, with the attendant possibilities of deterioration. Thus, samples made from the lowest grade eggs which might legitimately be used for food purposes were assured. It was further determined that the samples should be examined in the same city in which they were prepared, in order to eliminate all railroad transportation.

A series of samples was prepared from the different grades made commercially, allowing the breakers to follow their usual system of grading; a similar series in which the grading was done by members of the Bureau of Chemistry; and a series including a composite sample of each class of eggs considered inedible, in so far as they were obtainable. Records of the eggs used in making these samples were kept. The preparation of each type of sample was repeated in as many different factories, using different raw material, as many times as possible.

PRELIMINARY INVESTIGATION.

In order that all the analysts might have a good working knowledge of the methods of examination before assembling for the analysis of the frozen samples, and to obtain data on fresh eggs of high quality and on storage eggs, they were requested to carry out the following procedure in their home laboratories during the early summer:

1. On five different days, each laboratory shall obtain a representative sample of absolutely fresh eggs. These shall be opened aseptically according to the method described, the yolks and whites shall be thoroughly mixed together under aseptic conditions, and the mixture shall be subjected to bacteriological, chemical, physical, and microscopical examination.
2. On five different days, each laboratory shall obtain a representative sample of absolutely fresh eggs. These shall be opened aseptically according to the method described, and the yolks and whites separated. The thoroughly mixed yolks and the thoroughly mixed whites shall each be subjected to bacteriological, chemical, physical, and microscopical examination.
3. On five different days, each laboratory shall obtain a representative sample of eggs which have been in cold storage, but which are still considered edible, and shall proceed as under No. 1.
4. On five different days, each laboratory shall obtain a representative sample of eggs which have been in cold storage, but which are still considered edible, and shall proceed as under No. 2.

RESULTS OF PRELIMINARY INVESTIGATION.

The results of this part of the investigation are given in Tables 1 to 7, which also include data obtained by one of the laboratories in the examination of some May eggs transported from Tennessee and Ohio to the Atlantic seaboard, and there opened under commercial conditions.

TABLE 1.—*Results of examination of whole egg from approximately 24 eggs, opened and mixed as soon after being laid as possible.*

Sample No.	Date analyzed.	Description of sample.	Odor.	Total solids (wet basis).	Ether extract (wet basis).	Ammonia nitrogen (wet basis).		Acidity of fat as N/20 sodium ethylate.	Reducing sugar as dextrose (wet basis).	Indol and skatol.	Organisms per gram.		
						Titration.	Nesslerization.				Plain agar, 20°C., 5 days.	Plain agar, 37°C., 2 days.	Confirmed *B. coli.*
E. D.:	1917.			*Per cent.*	*Per cent.*	*Mg. per 100 grams.*	*Mg. per 100 grams.*	*Cc. per gram.*	*Per cent.*				
5411	July 16	Whole egg, "strictly fresh"[1]	Good	25.97	9.32	1.8		1.30	0.30	0	0	0	0
5412	July 18	do.[1]	do	26.17	9.62	[2]2.4	1.6	1.71	.34	0	0	0	0
5416	July 20	do.[1]	do	26.06	9.75	2.0	[3]3.0	1.21	.33	0	0	0	0
C. D.:													
1	July 30	Whole egg, between 1 and 2 days old	do	26.75	9.96	[4]3.8		1.59	.35				
2	Aug. 1	do	do	26.46	9.81	[4]2.8		1.46	.31				
3	Aug. 2	do	do	26.85	9.97	1.6		1.47	.34				
4	Aug. 3	do	do	26.49	10.12	1.8		1.61	.34				
5	Aug. 4	do	do	25.96	9.31	1.5		1.48	.36				
W. D.:													
3972	June 18	Whole egg, laid June 16 and 17	Faint and pleasant.	26.96	10.19	1.0	1.3	1.44	.29				
3973	June 20	Whole egg, laid June 17	do	26.14	9.38	1.1	1.0	1.28	.30				
3974	June 22	Whole egg, laid June 20	do	26.28	9.75	1.1	1.4	1.39	.30				
3975	June 25	Whole egg, laid June 22	do	26.73	10.03	1.2	1.2	1.33	.32	0			
4476	June 28	Whole egg, laid June 26	do	26.52	9.92	1.1	.9	1.54	.32	0			
A. P. C.:													
6266		Whole egg, not over 24 hours old, from a poultry farm.		26.90	10.59	1.7	1.2	1.66	.31				
6270		do		26.98	10.59	1.5	1.4	1.70	.33				
6273		do		26.63	10.07	1.2	1.2	1.72	.30				
6276		do		27.19	10.70	1.7			.30				
6279		do		27.00	11.01	1.6	1.3		.32				
F. R.:													
528		Whole egg, not over 48 hours old, sold as strictly fresh.[5]		26.18	9.97	1.4		1.47	.33		0	0	
		Average[6]		26.54	10.00	1.5	1.3	1.49	.32	0	0	0	0
		Maximum[6]		27.19	11.01	2.0	1.6	1.72	.36	0	0	0	0
		Minimum[6]		25.96	9.31	1.0	.9	1.21	.29	0	0	0	0

Formula value: Average=—16.27.

[1] All eggs apparently normal; 23 eggs used.
[2] Too rapid aeration caused loss of acid in receiving flask.
[3] Cloudy solution interfered with nesslerization.
[4] Sodium carbonate carried over as spray.
[5] About one-half of eggs showed beginning incubation. Appeared fresh before candle.
[6] Abnormal figures omitted.

TABLE 2.—*Results of examination of freshly prepared commercial whole egg.*

Sample No.	Date analyzed.	Description of sample.	Odor.	Total solids (wet basis).	Ether extract (wet basis).	Ammonia nitrogen (wet basis).		Acidity of fat as sodium ethylate.	Reducing sugar as dextrose.	Indol and skatol.	Organisms per gram.		
						Titration.	Nesslerization.				Plain agar, 20° C., 5 days.	Plain agar, 37° C., 2 days.	Confirmed *B. coli.*
F. R.:	1917.			*Per cent.*	*Per cent.*	*Mg. per 100 grams.*		*Cc. per gram.*					
1	May 23	Whole egg, a. m., Tennessee firsts		26.92	9.95	2.0		1.74			1,100,000	550,000	
2	May 23	Whole egg, p. m., Tennessee firsts		26.78	9.73	2.0		1.81			750,000	220,000	
5	May 24	Whole egg, a. m., Tennessee firsts		27.89	10.48	2.0		1.64			900,000	550,000	
6	May 24	Whole egg, p. m., Tennessee firsts		27.37	10.33	1.9		1.72			70,000	17,000	
8	May 25	Whole egg, Ohio dirties		27.51	10.35	1.6		1.91			280,000	140,000	
9	May 25	Whole egg, Tennessee seconds		28.39	10.56	2.3		1.89			2,300,000	350,000	
11	May 28	Whole egg, a. m., Tennessee seconds		27.18	9.66	1.9		1.81			800,000	2,000,000	
12	May 28	Whole egg, p. m., Tennessee seconds		27.84	10.29	2.1		1.91			1,100,000	600,000	
14	May 29	Whole egg, a. m., cracks and dirties		27.49	10.24	1.9		1.66			4,400,000	1,800,000	
15	May 29	Whole egg, p. m., cracks and dirties		28.57	11.20	1.9		1.89			3,100,000	3,700,000	
		Average		27.59	10.28	2.0		1.80			1,500,000	1,000,000	
		Maximum		28.57	11.20	2.3		1.91			4,400,000	3,700,000	
		Minimum		26.78	9.66	1.6		1.66			70,000	17,000	

Formula value: Average = −7.18.

TABLE 3.—*Results of examination of yolk from approximately 48 eggs opened, separated, and mixed as soon after being laid as possible.*

Sample No.	Date analyzed.	Description of sample.	Odor.	Total solids (wet basis).	Ether extract (wet basis).	Ammonia nitrogen (wet basis).		Acidity of fat as N/20 sodium ethylate.	Reducing sugar as dextrose.	Indol and skatol.	Organisms per gram.		
						Titration.	Nesslerization.				Plain agar, 20° C., 5 days.	Plain agar, 37° C., 2 days.	Confirmed *B. coli.*
E. D.:	1917.			*Per cent.*	*Per cent.*	*Mg. per 100 grams.*	*Mg. per 100 grams.*	*Cc. per gram.*	*Per cent.*				
5421	July 23	Yolk "strictly fresh"	Good	48.95	24.94	2.9	[1] 4.5	1.84	0.16	0			
5422	July 25	do	do	50.24	26.97	2.6	[1] 6.2	1.68		0			
5424	July 27	do	do	50.15	26.33	[2] 1.1	[2] 1.4	1.71	.14	0			
C. D.:													
1	July 30	Yolk, between 1 and 2 days old	do	47.32	24.89	[3] 4.6		1.76	.19				
2	Aug. 1	do	do	48.31	25.50	[3] 3.7		1.68	.18				
3	Aug. 2	do	do	47.88	25.13	2.8		1.62	.19				
4	Aug. 3	do	do	50.17	26.75	3.1		1.74	.18				
5	Aug. 4	do	do	50.04	26.33	2.6		1.56	.19				
W. D.:													
4477	July 3	Yolk, laid July 1	Faint and pleasant.	50.62	28.78	2.5	2.6	1.79	.12				
4478	July 10	Yolk, laid July 8	do	50.90	28.13	2.7	2.8	1.75	.09	0			
4479	July 11	Yolk, laid July 9	do	50.67	27.41	2.6	2.7	1.66	.08				
4480	July 16	Yolk, laid July 13	do	50.24	27.13	2.5	2.6	1.56	.09				
4481	July 17	Yolk, laid July 15	do	50.70	27.43	2.6	1.9	1.44	.11				
A. P. C.:													
6267		Yolk, eggs not over 24 hours old, obtained from a poultry farm.		50.38	27.06	2.5	2.0	1.96	.14				
6271		do		50.07	27.23	2.6	2.1	1.90	.15				
6274		do		50.13	27.29	2.7	2.6	1.90	.12				
6277		do		50.38	27.06	2.7	2.5		.15				
6280		do		50.16	27.74	2.6	2.7		.13				
F. R.:													
529		Yolk, eggs not over 48 hours old; sold as strictly fresh.[4]		46.93	24.49	2.8		1.74	.20		0	0	
		Average[5]		49.69	26.66	2.7	2.5	1.72	.14	0	0	0	
		Maximum[5]		50.90	28.78	3.1	2.8	1.96	.20	0	0	0	
		Minimum[5]		46.93	24.49	2.5	1.9	1.44	.08	0	0	0	
E. D.:													
5417	July 27	Yolk, eggs held 10 days in laboratory	Good	48.52	25.55	7.0	8.9	2.63	.19	0			

Formula value: Average = —36.66.

[1] Cloudy solution interfered with nesslerization.
[2] Too low, incomplete aeration.
[3] Too high, sodium carbonate carried over as spray.
[4] About one-half of eggs showed signs of beginning incubation; appeared fresh before candle.
[5] Abnormal figures omitted.

TABLE 4.—*Results of examination of white from approximately 48 eggs opened, separated, and mixed as soon after being laid as possible.*

Sample No.	Date analyzed.	Description of sample.	Odor.	Total solids (wet basis).	Ether extract (wet basis).	Ammonia nitrogen (wet basis).		Acidity of fat as N/20 sodium ethylate.	Reducing sugar as dextrose (wet basis).	Indol and skatol.	Organisms per gram.		
						Titration.	Nesslerization.				Plain agar, 20°C., 5 days.	Plain agar, 37°C., 2 days.	Confirmed *B. coli.*
	1917.			*Per cent.*	*Per cent.*	*Mg. per 100 grams.*	*Mg. per 100 grams.*	*Cc. per gram.*	*Per cent.*				
E. D.:													
5421	July 23	White, "strictly fresh"	Good	12.40		1.1	1.4		0.44	0			
5422	July 25	do	do	12.20	0.02		1.7	0.0	.40	0			
5424	July 27	do	do	12.48	.01	1.2	.6	.0	.31	0			
C. D.:													
1	July 30	White, between 1 and 2 days old	do	12.56	.03	[1] 1.6			.46				
2	Aug. 1	do	do	12.77	.01	[1] 2.8			.43				
3	Aug. 2	do	do	12.30	.01	.6			.44				
4	Aug. 3	do	do	12.25	.03	.8			.41				
5	Aug. 4	do	do	12.44	.02	(2)			.46				
W. D.:													
4477	July 3	White, laid July 1	Faint and pleasant.	12.83		.2	.2		.38				
4478	July 10	White, laid July 8	do	12.34		.3	Trace		.37	0			
4479	July 11	White, laid July 9	do	12.83		.0	do		.41				
4480	July 16	White, laid July 13	do	12.14		.0	do		.37				
4481	July 17	White, laid July 15	do	12.69		.0	.0		.32				
A. P. C.:													
6268		White, eggs not over 24 hours old, from a poultry farm.		11.99	.09	.9	.5		.40				
6272		do		11.80	.10	.5	.6		.42				
6275		do		12.08	.12	.6	.4		.37				
6278		do		12.43	.07	.8	.5		.44				
6281		do		12.19	.11	.7	.3		.39				
F. R.:													
530		White, eggs not over 48 hours old, sold as strictly fresh. [3]		12.02	.03	.3			.45		0	0	
		Average [4]		12.35	.05	.5	.5	.0	.40	0	0	0	
		Maximum [4]		12.83	.12	1.2	1.7	.0	.46	0	0	0	
		Minimum [4]		11.80	.01	.0	.0	.0	.31	0	0	0	
E. D. 5417	July 27	White, eggs held 10 days in laboratory.		12.43	.02	2.1	1.6	.0	.38	0			

Formula value: Average = —0.32.

[1] Foamed over; too high because sodium carbonate carried over as spray.
[2] Foamed over.
[3] About one-half of eggs showed signs of beginning incubation; appeared fresh before candle.
[4] Abnormal figures omitted.

TABLE 5.—*Results of examination of whole egg from approximately 24 eggs opened and mixed after being held in commercial cold storage.*

Sample No.	Date analyzed.	Description of sample.	Odor	Total solids (wet basis).	Ether extract (wet basis).	Ammonia nitrogen (wet basis).		Acidity of fat as N/20 sodium ethylate.	Reducing sugar as dextrose (wet basis).	Indol and skatol.	Organisms per gram.		
						Titration.	Nesslerization.				Plain agar, 20°C., 5 days.	Plain agar, 37°C., 2 days.	Confirmed *B. coli.*
				Per cent.	*Per cent.*	*Mg. per 100 grams.*	*Mg. per 100 grams.*	*Cc. per gram.*	*Per cent.*				
E. D.:	1917.												
5801	Aug. 1	Stored April 12, 1917; held for 4 months in New York.[1]	Good	27.27	11.25		5.1		0.37	0			
5802	Aug. 2	do	do	28.27	10.42		2.9	1.44	.35	0			
5803	Aug. 3	do[2]	do	28.43	10.73	2.7	3.4	1.55	.36	0			
		Average[3]		27.99	10.80	2.7	3.2	1.50	.36	0			
A. P. C.:													
6326		Held for 7 months in Washington, D. C.[4]	Good	28.23	10.74	2.8	3.1	1.56	.29	0			
6329		do.[4]	do	28.19	10.77	2.4	2.8	1.60	.30	0			
6331		do.[4]	do	28.26	10.72	2.9	2.7	1.56	.31	0			
6337		do.[4]	do	29.19	10.69	2.9	2.8	1.60	.32	0			
6340		do.[4]	do	28.11	11.00	2.3	2.6	1.68	.34	0			
		Average		28.20	10.78	2.7	2.8	1.60	.31	0			
C. D.:													
1	Dec. 11	Stored April 20, 1917; held for 8 months in Chicago; candled when taken from storage.[6]	Good	28.41	10.69	2.4	(5)	1.79	.37	0			
2	Dec. 12	do.[6]	do	28.22	10.49	2.6	2.8	1.85	.36	0			
3	Dec. 13	do.[6]	do	28.06	10.55	2.7	2.4	1.88	.33	0			
4	Dec. 14	do	do	28.06	10.56	2.6	(5)	1.87	.31	0			
5	Dec. 15	do	Strong	26.74	9.96	2.4	(5)	1.93	.28	0			
W. D.:													
4488	Nov. 16	Store eggs, mixed colors; held for 8 months in San Francisco.[7]		28.09	10.68	3.2	2.6	1.69	.32				
4489	Nov. 21	Fancy ranch eggs; held for 8 months in San Francisco.[7]		27.87	10.56	2.5	2.1	1.76	.33				
4490	Nov. 21	do.[7]		27.41	9.93	2.6	2.3	1.88	.34				
4491	Nov. 21	do.[7]		28.22	10.91		2.8	1.82	.34				
4492	Nov. 26	do.[7]		27.72	10.90	2.6	2.6		.32				
		Average[8]		27.88	10.52	2.6	2.5	1.83	.33	0			

F. R.:													
525		May firsts from Iowa; held in Philadelphia from May, 1916, to June, 1917 (13 months).[8]	Not good.	29.34	10.88	3.2		1.68	.39		0	0	
525a		do.[8]	do						.42				
		Average		29.34	10.88	3.2		1.68	.41		0	0	

Formula values: E. D.= −7.35+; A. P. C.= −5.22+; C. D. and W. D.= −3.82+; F. R.= −2.89.

[1] Two eggs had cloudy whites; solids developed bad odor when drying.
[2] One spot, bloody white.
[3] Abnormal figures omitted.
[4] Appearance good.
[5] Lost by foaming.
[6] Shrinkage was marked; whites were viscous.
[7] All rigidly candled before stored.
[8] Four eggs out of 72 discarded; eggs used looked edible, but considered inedible because had slight odor and taste resembling damp fillers. Shrinkage was marked; yolks somewhat weak and whites slightly tinged with yellow, probably due to diffusion from yolks.

TABLE 6.—*Results of examination of yolk from approximately 48 eggs opened, separated, and mixed after being held in commercial cold storage.*

Sample No.	Date analyzed.	Description of sample.	Odor.	Total solids (wet basis).	Ether extract (wet basis).	Ammonia nitrogen (wet basis).		Acidity of fat as N/20 sodium ethylate.	Reducing sugar as dextrose (wet basis).	Indol and skatol.	Organisms per gram.		
						Titration.	Nesslerization.				Plain agar, 20°C., 5 days.	Plain agar, 37°C., 2 days.	Confirmed *B. coli.*
				Per cent.	*Per cent.*	*Mg. per 100 grams.*	*Mg. per 100 grams.*	*Cc. per gram.*	*Per cent.*				
E. D.:	1917.												
5805....	Aug. 6	Stored April 12, 1917; held for 4 months in New York.[1]	Good......	39.23	19.13	4.0	4.7	1.51	0.26	0	0	0	0
5804....	Aug. 7	.....do.[2]......	.....do.....	37.77	18.01	3.6	4.1	1.58	.21	0	650	850	0
5806....	Aug 8	.....do.[3]......	.....do....	41.29	20.58	3.9	3.9	1.49	.22	0	260,000	150,000	0
		Average........	....	39.43	19.24	3.8	4.2	1.53	.23	0	87,000	50,000	0
A. P. C.:													
6327....	....	Held for 7 months in Washington, D. C.[4]	Good.....	43.66	22.60	4.5	4.4	1.63	.20	0	....	....	....
6330....	....	.....do.[4]......	.....do.....	42.66	22.05	5.0	4.6	1.69	.20	0	....	....	....
6332....	....	.....do.[4]......	....	43.59	22.49	4.9	4.2	1.66	.21	0	....	....	....
6338....	....	.....do.[4]......	Good......	42.52	22.16	4.0	4.3	1.76	.22	0	....	....	....
6341....	....	.....do.[4]......	.....do....	41.93	20.84	4.4	4.4	1.80	.24	0	....	....	....
		Average........	....	42.87	22.03	4.6	4.4	1.71	.21	0	....	....	....
C. D.:													
1.......	Dec. 11	Stored April 20, 1917; held for 8 months in Chicago; candled when taken from storage.[5]	Good......	41.39	20.70	5.0	(6)	1.81	.23	0	....	....	....
2.......	Dec. 12	.....do.[5]......	.....do.....	43.71	22.22	5.2	4.8	1.82	.21	0	....	....	....
3.......	Dec. 13	.....do.[5]......	.....do.....	43.64	22.36	4.9	4.5	1.81	.19	0	....	....	....
4.......	Dec. 14	.....do.[5]......	.....do.....	43.49	22.47	4.5	(6)	1.77	.21	0	....	....	....
5.......	Dec. 15	.....do.[5]......	.....do.....	42.84	21.89	4.6	6.0	1.77	.19	0	....	....	....
W. D.:													
4493....	Nov. 26	Store eggs, mixed colors; held for 8 months in San Francisco.	....	42.60	22.00	4.8	4.6	1.82	.16	....	....	....	....
4494....	Dec. 3	Fancy ranch eggs; held for 8 months in San Francisco.[7]	....	42.32	21.54	4.9	4.4	1.88	.13	....	....	....	....
4495....	Dec. 3	.....do.[7]......	....	43.69	22.86	4.8	4.7	1.74	.16	....	....	....	....
4496....	Dec. 3	.....do.[7]......	....	44.07	22.83	4.9	5.1	1.87	.17	....	....	....	....
4497....	Dec. 5	.....do.[7]......	....	42.71	21.98	5.0	5.1	1.89	.18	....	....	....	....
		Average........	....	43.05	22.09	4.9	4.9	1.82	.18	0	....	....	....

F. R.:													
526	....	May firsts from Iowa; held in Philadelphia from May, 1916, to June, 1917 (13 months).[8]	Not good	43.87	22.74	6.4	....	1.78	.26	....	0	0	....
526a	....	do.[8]	do	....	....	....	....	....	.31	....	....	....	....
		Average	....	43.87	22.74	6.4	....	1.78	.29	....	0	0	....

Formula values: E. D.= −12.93; A. P. C.= −8.06+; C. D. and W. D.= −4.43+; F. R.= +5.91.

[1] All eggs apparently normal; 6 out of 48 eggs discarded.
[2] One egg had yellowish tint in albumen; remainder apparently as normal as fresh eggs; 3 eggs discarded.
[3] Whites of two eggs had yellowish discoloration; other eggs apparently as normal as fresh eggs; 4 eggs discarded.
[4] Appearance good; in most cases it was hard to separate the yolks from the whites.
[5] Shrinkage was marked; whites were so viscous that it was difficult to completely separate whites from yolks.
[6] Lost by foaming.
[7] All rigidly candled before stored; difficult to completely separate whites from yolks.
[8] Four out of 72 eggs discarded; eggs used looked edible, but considered inedible because had slight odor and taste resembling damp fillers; shrinkage was marked; yolks somewhat weak and whites slightly tinged with yellow, probably due to diffusion from yolks.

TABLE 7.—*Results of examination of white from approximately 48 eggs opened, separated, and mixed after being held in commercial cold storage.*

Sample No.	Date analyzed.	Description of sample.	Odor.	Total solids (wet basis).	Ether extract (wet basis).	Ammonia nitrogen (wet basis).		Acidity of fat as N/20 sodium ethylate.	Reducing sugar as dextrose (wet basis).	Indol and skatol.	Organisms per gram.		
						Titration.	Nesslerization.				Plain agar, 20° C., 5 days.	Plain agar, 37° C., 2 days.	Confirmed *B. coli.*
E. D.:	1917.			*Per cent.*	*Per cent.*	*Mg. per 100 grams.*	*Mg. per 100 grams.*		*Per cent.*				
5805	Aug. 6	Stored April 12; held for 4 months in New York.[1]	Good	14.60	0.13		0.6		0.50	0	0	3	0
5804	Aug. 7	do.[2]	do	15.12	.13	0.8	.5		.51	0	34,000	29,000	0
5806	Aug. 8	do.[3]	do	14.18	.03	.8	[4]1.7		.44	0	290,000	270,000	0
		Average[5]		14.63	.03	.8	.6		.48	0	110,000	100,000	0
A. P. C.:													
6328		Held for 7 months in Washington, D. C.[6]	Good	14.04		.7	.4		.35	0			
6331		do.[6]	do	14.20	.07	.8	.6		.35	0			
6333		do.[6]	do	14.70		.7	.4		.37	0			
6339		do.[6]	do	14.02		.6	.4		.38	0			
6342		do.[6]	do	14.11		.4	.3		.41	0			
		Average		14.21	.07	.6	.4		.37	0			
C. D.:													
1	Dec. 11	Stored April 20; held for 8 months in Chicago; candled when taken from storage.[7]	Good	13.78	.05	.8	([8])		.47	0			
2	Dec. 12	do.[7]	do	14.15	.05	.6	.3		.45	0			
3	Dec. 13	do.[7]	do	13.02	.03	.5	1.3		.42	0			
4	Dec. 14	do.[7]	do	13.92	.03	.6	([8])		.40	0			
5	Dec. 15	do.[7]	do	13.42	.05	.5	([8])		.40	0			
W. D.:													
4493	Nov. 26	Store eggs, mixed colors, held for 8 months in San Francisco.[9]		14.28		0	0		.48				
4494	Dec. 3	Fancy ranch eggs, held for 8 months in San Francisco.[9]		14.38					.42				
4495	Dec. 3	do.[9]		14.64					.42				
4496	Dec. 3	do.[9]		13.89					.42				
4497	Dec. 5	do.[9]		14.07					.42				
		Average[5]		13.96	.04	.5	.5		.43	0			

F. R.:													
527	....	May firsts from Iowa, held in Philadelphia from May, 1916, to June, 1917 (13 months).[10]	Not good	15.54	.03	.4	....	....	.54	....	0	0	....
527*a*	....	do[10]	do	....	....	....	....	....	.55	....	....	....	....
		Average	....	15.54	.03	.4	....	....	.55	....	0	0	....

Formula values: E. D.= −0.92; A. P. C.= +0.06+; C. D. and W. D.= −2.06+; F. R.= −7.36.

[1] Some yolk in whites; 6 out of 48 eggs discarded.
[2] Some yolk in whites; 1 egg had yellowish tint in albumen; 3 out of 48 eggs discarded.
[3] The whites of 2 eggs had yellowish discoloration; 4 out of 48 eggs discarded.
[4] Cloudy solution interfered with nesslerization.
[5] Abnormal figures omitted.
[6] Appearance good; in most cases it was difficult to separate the whites from the yolks.
[7] Shrinkage was marked; whites were so viscous that it was difficult to completely separate yolks.
[8] Lost by foaming.
[9] All rigidly candled before stored; difficult to completely separate whites from yolks.
[10] Four out of 72 eggs discarded; eggs used looked edible, but considered inedible because had slight odor and taste resembling damp fillers; shrinkage marked; yolks somewhat weak and whites slightly tinged with yellow, probably due to diffusion from yolks.

DISCUSSION OF RESULTS OF PRELIMINARY INVESTIGATION.

The following facts are evident from the data given in Tables 1 to 7, inclusive:

1. The analytical results agree remarkably for all egg samples examined, whether they were purchased and examined in New York, Philadelphia, Washington, Chicago, or San Francisco. This is true for eggs opened as soon after being laid as possible, as well as for those which were held in cold storage for approximately equivalent periods of time. From the regulatory point of view this is important, since it shows that but one basis of judgment as to quality is necessary for the whole of the United States.

2. The limits of variation (Tables 1, 3, and 4) found in the freshest eggs obtainable, opened aseptically in June and July, were as follows:

In whole egg.—For total solids, 25.96 to 27.19 per cent; for ether extract, 9.31 to 11.01 per cent; for ammonia nitrogen, 1 to 2 milligrams per 100 grams; for acidity of fat, 1.21 to 1.72 cc. of N/20 sodium ethylate required per gram; for reducing sugar, 0.29 to 0.36 per cent. No bacteria of any kind were found in any of the samples examined for bacteria.

In yolk.—For total solids, 46.93 to 50.90 per cent; for ether extract, 24.49 to 28.78 per cent; for ammonia nitrogen, 2.5 to 3.1 milligrams per 100 grams; for acidity of fat, 1.44 to 1.96 cc. of N/20 sodium ethylate required per gram; for reducing sugar, 0.08 to 0.20 per cent. No bacteria of any kind were found in any of the samples examined for bacteria.

In white.—For total solids, 11.80 to 12.83 per cent; for ether extract, 0.01 to 0.12 per cent; for ammonia nitrogen, 0.0 to 1.2 milligrams per 100 grams; for reducing sugar, 0.31 to 0.46 per cent. No bacteria of any kind were found in any of the samples examined for bacteria. What is meant by formula values is explained on page 66.

3. The limits of variation (Tables 5, 6, and 7), found in April and May eggs which had been held in cold storage from four to eight months and which were opened aseptically, were as follows:

In whole egg.—For total solids, 27.88 to 28.20 per cent; for ether extract, 10.52 to 10.80 per cent; for ammonia nitrogen, 2.6 to 2.7 milligrams per 100 grams; for acidity of fat, 1.50 to 1.83 cc. of N/20 sodium ethylate required per gram; for reducing sugar, 0.31 to 0.36 per cent. No bacteria of any kind were found in any of the samples examined for bacteria.

In yolk.—For total solids, 39.43 to 43.05 per cent; for ether extract, 19.24 to 22.09 per cent; for ammonia nitrogen, 3.8 to 4.9 milligrams per 100 grams; for acidity of fat, 1.53 to 1.82 cc. of N/20 sodium ethylate required per gram; for reducing sugar, 0.18 to 0.23 per cent. As many as 260,000 bacteria per gram were found.

In white.—For total solids, 13.96 to 14.63 per cent; for ether extract, 0.03 to 0.07 per cent; for ammonia nitrogen, 0.4 to 0.8 milligram per 100 grams; for reducing sugar, 0.37 to 0.48 per cent. As many as 290,000 bacteria per gram were found.

4. The variations in chemical composition (Tables 5, 6, and 7), as would be expected, closely parallel the length of time the eggs were stored.

In whole egg.—The total solids tend to increase slightly; the ether extract to decrease; the ammonia nitrogen to show little change during the first eight months, after which there was a marked increase; the acidity of fat to increase markedly; and the reducing sugar to decrease during the first eight months, after which there was a marked increase.

In yolk.—All of the chemical constituents tend to increase markedly, with the exception of the reducing sugar, which tends to decrease during the first eight months, after which there was a marked increase.

In white.—The total solids tend to decrease slightly, followed by an increase; the ether extract and ammonia nitrogen to show little change; the reducing sugar to decrease and then to increase markedly.

5. The changes in the total solids and ether extract in storage eggs (Tables 5, 6, and 7) are believed to be due primarily to evaporation of moisture through the shell of the egg, and secondarily to decomposition. The changes in ammonia nitrogen, acidity of fat, and reducing sugar are believed to be due primarily to decomposition and secondarily to evaporation. The decrease in the substances measured as reducing sugar by the method employed is believed to be due to a biological decomposition of true reducing sugars, while the marked increase which was noted on longer storage is believed to be due to the breaking down of some of the ovomucoid, which is a glycoprotein and on hydrolysis yields a reducing substance, probably chondroitin-sulphuric acid. This may break down into glucosamine or some similar substance.

6. As showing the deterioration which takes place, especially in the yolk, on long storage, the results obtained from May eggs which had been in cold storage for 13 months (Tables 5, 6, and 7) are of more than passing interest. These eggs looked edible, but were considered inedible because they had a slight odor and taste resembling damp fillers, and were markedly shrunken, with somewhat weak yolks and with whites slightly tinged with yellow, probably due to diffusion from the yolks. The average results obtained were:

In whole egg.—For total solids, 29.34 per cent; for ether extract, 10.88 per cent; for ammonia nitrogen, 3.2 milligrams per 100 grams; for acidity of fat, 1.68 cc. of N/20 sodium ethylate required per gram; for reducing sugar, 0.39 per cent. No bacteria were found in the one sample examined.

In yolk.—For total solids, 43.87 per cent; for ether extract, 22.74 per cent; for ammonia nitrogen, 6.4 milligrams per 100 grams; for acidity of fat, 1.78 cc. N/20 sodium ethylate required per gram; for reducing sugar, 0.29 per cent. No bacteria were found in the one sample examined.

In white.—For total solids, 15.54 per cent; for ether extract, 0.03 per cent; for ammonia nitrogen, 0.4 milligram per 100 grams; for reducing sugar, 0.55 per cent. No bacteria were found in the one sample examined.

7. A comparison of the chemical results obtained from fresh eggs (Tables 1, 3, and 4) with those obtained from eggs which had been held in cold storage (Tables 5, 6, and 7), in which there was a progressive deterioration as the length of time in storage increased, justifies the statement that cold storage does not preserve eggs in the condition in which they were when placed in storage, but merely retards decomposition and deterioration and keeps them in a marketable condition for several months.

8. In sample 5417, ammonia nitrogen of 7 milligrams per 100 grams in the case of the yolk (Table 3) and of 1.6 milligrams per 100 grams in the case of white (Table 4), together with acidity of the fat in the case of yolk of 2.63 cc. of N/20 sodium ethylate required per gram, when compared with the results already cited for fresh eggs (Tables 3 and 4), are of interest as showing how very perishable the egg is and what great changes in composition take place, even while the eggs are still in the shell, when held for as short a period as 10 days without refrigeration.

9. In the case of the whole egg samples (Table 2) prepared commercially during the month of May from firsts, seconds, cracks, and dirties, which, it should be remembered, had been transported over long distances, the average total solids determination of 27.59 per cent and the average ether extract determination of 10.28 are higher than the corresponding average figures of 26.54 and 10 in the case of the strictly fresh egg samples (Table 1), indicating either a shrinkage due to evaporation or the mechanical loss of some of the more watery white. The average ammonia content figure of 2 milligrams per 100 grams and the average acidity of fat figure of 1.80 cc. N/20 sodium ethylate required per gram are higher than the corresponding average figures of 1.5 and 1.49 in the case of fresh eggs, as would be expected, and indicate clearly incipient decomposition. The average figure of 1,500,000 bacteria per gram in these commercial samples, as compared with the lack of bacteria in the fresh whole egg samples prepared aseptically, results from the fact that the eggs composing these samples were taken from commercial breaking stock and were opened under commercial conditions.

10. A comparison of the average results for acidity of fat of 1.49 and 1.72 cc. of N/20 sodium ethylate required per gram, respectively, in whole egg (Table 1) and in yolk (Table 3), both prepared from the freshest eggs obtainable, shows that higher figures were obtained in the case of yolk. Theoretically, the figures should be identical, or very nearly so. It is possible that this difference is due to the removal of substances from the white of the egg by the solvent or by the presence during drying of a relatively large amount of protein in the whole egg. For a tabular summary of this discussion see Table 26 (page 76).

PROGRESS OF THE INVESTIGATION.

PREPARATION OF SAMPLES.

Early in August, 1917, under the supervision of two representatives of the Bureau of Chemistry who have had wide experience in grading eggs both before the candle and while out of the shell, the frozen egg samples were prepared in four commercial houses which are as well equipped as the average breaking plant. In candling and grading the eggs and in preparing the samples representatives of the manufacturers were always present. The manufacturers showed a most gratifying spirit of cooperation throughout the entire investigation. During the preparation of the samples careful records were made of all the available information concerning the past history of the breaking stock and its distribution. As far as possible records were also kept of the number and kinds of eggs which entered each sample. In the case of the samples designated as commercial in Tables 8 to 23 the manufacturers were allowed to follow their own grading, of which the Bureau representatives kept a careful record. In the samples designated as experimental the grading was done by the Bureau of Chemistry representatives.

The Department of Agriculture has taken the position that only two grades of frozen egg material should be prepared—namely, food egg and tanners' egg.[1] Several manufacturers, however, prepare more than one grade of food product. For this reason experimental samples presumably of more than one grade were prepared, but this fact is not to be considered as indicating the approval of the Bureau of Chemistry of such a procedure commercially. In a number of cases as nearly as possible identical types of samples were prepared in several different houses with different raw materials, different equipment, and different breakers.

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[1] U. S. Dept. Agr. Bul. 224, p. 21.

EXAMINATION OF SAMPLES.

After the samples had been prepared, frozen, and held in cold storage for several weeks they were examined by three bacteriologists and five chemists. Only one determination of each constituent was made by each chemist, for the reason that four or five chemists performed each determination, averages of which give very reliable results. All bacteriological examinations were made in duplicate.

RESULTS OF EXAMINATION OF SAMPLES.

The results of the examination of the samples are given in Tables 8 to 23. For ease of comparison the histories of the samples and the analytical results have been grouped in the same table. Moreover, all of the samples of the same type have been gathered into each table, and averages have been calculated. These tables are self-explanatory, needing but the few additional comments which are given on pages 55 to 59. Throughout, the use of terms as given in U. S. Department of Agriculture Bulletin 224, page 21, has been followed.

TABLE 8.—*Results of examination of frozen experimental first-grade whole egg containing no sugar or salt (grading dictated).*

Sample No.	Date prepared.	Initial of investigator.	Eggs in shell.					Eggs in breaking room.								Size of sample.	How churned.	Time consumed in preparing sample.	Odor when put in freezer.	Temperature of freezer.
											Distribution.									
			Previous history.	Kind of eggs.	Date received.	Date candled.	Temperature of holding room.	Temperature of breaking room.	Number of breakers.	Number of eggs graded.	Used in sample.	As first grade.	As soft grade.	As second grade.	As tanner grade.					
	1917.				1917.	1917.	°F.	°F.			*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*Lbs.*		*Hrs.*		°F.
29	Aug. 9	R.	Current receipts from Jacksonville, Ill.	Graded from case pack.[1]	Aug. 4	Aug. 9	37	74	2	......	......	......	......	......	......	31	Small power churn.	3	Good.....	−5
34	...do....	J.	Cracks from Jacksonville, Ill.	Cracks[2]	...do....	...do....	37	74	1	......	......	......	......	......	......	15	.....do............	1	...do.....	−5
35	...do....	J.	.....do..................	.....do[3]............	...do....	...do....	37	74	1	......	......	......	......	......	......	10	.....do............	1	...do.....	−5
46	Aug. 10	R.	Cracks from June case pack and from Mt. Vernon, Ill...........	.....do[1]...........	Aug. 4, 6	Aug. 4, 6	36	62	1	......	......	......	......	......	......	26	....	3	...do.....	−7
64	Aug. 13	J.	Checks and dirties from Iowa.	Checks and dirties.[4]	Aug. 8, 11	Aug. 11, 13	40	66	1	581	57	57	26	16	1	30	In sample can, with sterile milk stirrer.	2	...do	−10
67	...do.....	J.	.....do................	.....do.[5]...........	...do....	...do....	40	66	1	......	......	......	......	......	......	29	.....do............	2	...do.....	−10
70	Aug. 14	R.	Checks and dirties from Wisconsin.	.....do.[1]...........	Aug. 13	Aug. 13, 14	40	62	1	1,265	45	45	37	12	6	27	.....do............	4	...do.....	−10

[1] Included only light hatch spots and stale infertiles.

[2] Included only light hatch spots, with firm yolks and clear whites.

[3] Included only stale infertiles, with firm yolks and clear whites.

[4] Included only eggs separable into yolk and white; all weak; many yolks had enlarged hatch spots; no blood; whites had lost opalescence.

[5] Included only light hatch spots or stale infertiles separable into yolk and white.

TABLE 8.—*Results of examination of frozen experimental first-grade whole egg containing no sugar or salt (grading dictated)*—Continued.

Sample No.	Date analyzed.	Initial of analyst.	Odor when analyzed.	Total solids (wet basis).	Ether extract (wet basis).	Ammonia nitrogen (wet basis).		Acidity of fat as N/20 sodium ethylate.	Reducing sugar as dextrose (wet basis).	Indol.	Skatol.	Physical examination.	Organisms per gram.				
						Titration.	Nesslerization.						Plain agar, 20° C., 120 hours.	Plain agar, 37° C., 48 hours.	Acid producers, 37° C., 48 hours.	Alkali producers, 37° C., 48 hours.	Confirmed *B. coli.*
	1917.			*Per ct.*	*Per ct.*	*Mg. per 100 grams.*	*Mg. per 100 grams.*	*Cc. per gram.*	*Per ct.*								
29	Aug. 28	B.	Good	27.65	10.72	2.1	2.1	1.94	0.33	0	0	Odor strong; appearance good; color normal; temp. 0° C.	9,900,000	3,000,000			10,000
		D.	Strong			1.9	1.6	1.98	.24	0	0						
		E.	Good	28.06	10.80	1.9	2.1	1.58	.32								
		H.	do	27.70	10.88	1.6	1.1	1.84					9,100,000	4,000,000			10,000
			Average.	27.80	10.80	1.9	1.7	1.84	.30	0	0		9,500,000	3,500,000			10,000
34	Aug. 29	D.	Good	28.67	11.28	2.1	3.4	1.85				Odor good; appearance good; color normal; temp. +1 ° C.					
		E.	do	28.56	11.41	2.0	2.1	1.99	.32								
		H.	do	28.26	11.34	2.1	1.5	1.76	.27	0	0		550,000	140,000	20,000	0	1,000
		S.	do	28.68	11.54	2.3	2.4		.31	0	0		800,000	250,000	20,000	0	1,000
			Average.	28.54	11.39	2.1	2.4	1.87	.30	0	0		650,000	200,000	20,000	0	1,000
35	do	B.								0	0	Odor good; appearance good; color normal; temp. +1° C.	11,000,000	5,300,000	290,000	0	10,000
		D.	Good	29.49	11.71	2.3	2.8	1.88									
		E.	do	29.36	11.87	2.1	2.4	1.95	.30				10,000,000	4,500,000	130,000	0	10,000
		H.	do	28.41	11.11	2.1	1.6	1.80	.29								
		S.	do	28.92	11.41	2.2	1.9	2.06	.29								
			Average.	29.05	11.53	2.2	2.2	1.92	.29	0	0		10,500,000	4,900,000	210,000	0	10,000
46	Aug. 31	B.	Good	26.65	10.37	1.9	1.6	1.79	.31	0	0	Odor good; appearance good; color normal; temp. +1° C.	2,900,000	1,700,000	440,000	20,000	100
		D.	do	27.45	11.15	2.3	2.2	1.99		0	0						

		H.	...do.....	27.66	10.96	2.1	1.8	....	.30	......	......	....	3,600,000	2,300,000	660,000	40,000	100
		S.	...do.....	26.59	10.06	2.1	1.9	1.90	.32	......	......	....	....	....	....	....	....
			Average.	27.09	10.64	2.1	1.9	1.89	.31	0	0	....	3,300,000	2,000,000	550,000	30,000	100
64	Sept. 5	D.	Good....	28.04	11.49	2.3	2.5	1.72	.30	0	0	Odor good; appearance good; color normal; temp. −2° C.	....	....	....	....	....
		E.	...do.....	27.67	10.55	2.3	2.4	1.89	.27	0	0						
		H.	...do.....	27.74	10.52	2.8	2.3	1.79	.30	......	......	....	3,400,000	1,600,000	550,000	100,000	100,000
		S.	...do.....	26.93	10.31	2.3	2.4	1.99	.34	......	......	....	2,900,000	1,400,000	550,000	100,000	100,000
			Average.	27.60	10.72	2.4	2.4	1.85	.30	0	0	....	3,200,000	1,500,000	550,000	100,000	100,000
67	...do...	D.	Good....	27.52	11.08	2.1	[1] 3.2	1.86	......	......	......	Odor good; appearance good; color normal; temp. −2° C.	....	....	....	....	....
		E.	...do.....	27.36	10.10	2.1	2.0	1.94	.28	......	......						
		H.	...do.....	26.93	10.59	2.5	2.3	1.69	.26	0	0	....	850,000	400,000	20,000	0	1,000
		S.	...do.....	27.06	10.43	2.2	2.4	1.93	......	0	0	....	550,000	650,000	20,000	0	1,000
			Average[2]	27.22	10.55	2.2	2.2	1.86	.27	0	0	....	700,000	550,000	20,000	0	1,000
70	Sept. 6	B.	Fair.....	28.15	10.92	2.4	2.5	1.85	.29	......	......	Odor good; appearance good; color normal; temp. −1° C.	....	....	....	....	....
		E.	Good....	27.66	10.94	2.1	2.2	1.90	.30	......	......						
		H.	...do.....	27.63	10.91	2.1	2.4	1.76	.27	0	0	....	130,000	80,000	52,000	0	100
		S.	...do.....	27.19	10.67	2.4	2.9	1.81	.30	0	0	....	110,000	80,000	48,000	0	100
			Average.	27.66	10.86	2.3	2.5	1.86	.29	0	0	....	120,000	80,000	50,000	0	100
Grand average[2]........				27.85	10.97	2.2	2.1	1.87	.29	0	0	....	4,000,000	1,800,000	230,000	22,000	17,500
Maximum........				29.05	11.53	2.4	2.5	1.92	.31	0	0	....	10,500,000	4,900,000	550,000	100,000	100,000
Minimum........				27.09	10.55	1.9	1.7	1.84	.27	0	0	....	120,000	80,000	20,000	0	100

[1] Cloudy solution interfered with nesslerization.

[2] Abnormal figures omitted.

Formula values: Sample 29= −8.39; sample 34= −9.24; sample 35= − 6.07; sample 46= −7.91; sample 64= − 4.11; sample 67= −5.44; sample 70= −5.82.

TABLE 9.—*Results of examination of frozen commercial first-grade whole egg containing no sugar or salt (grading observed and recorded in some).*

Sample No.	Date prepared.	Initial of investigator.	Eggs in shell.					Eggs in breaking room.								Size of sample.	How churned.	Time consumed in preparing sample.	Odor when put in freezer.	Temperature of freezer.
			Previous history.	Kind of eggs.	Date received.	Date candled.	Temperature of holding room.	Temperature of breaking room.	Number of breakers.	Number of eggs graded.	Distribution.									
											Used in sample.	As first grade.	As soft grade.	As second grade.	As tanner grade.					
	1917.				1917.	1917.	° F.	° F.			Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Lbs.		Hrs.		° F.
21	Aug. 8	H.	Current receipts from Jacksonville, Ill.	Graded out from case pack.[1]	Aug. 4	Aug. 8	37	74	4							27	Small power churn	1½	Good	− 5
40	Aug. 10	R.	Cracks from June case pack and current receipts from Mount Vernon, Ill.	Cracks and current receipts.[2]	Aug. 4 and 6	Aug. 4 and 6	36	62	1	318	92	92	0	7	1	25		2	do	− 7
43	do	J.	do	do.[3]	do	do	36	62	1	305	89	89	0	8	3	25		2½	do	− 7
60	Aug. 13	H.	Checks and dirties from Iowa.	Checks and dirties.[4]	Aug. 8 and 11	Aug. 11 and 13	40	66	10							15	Large power churn		do	−10
74	Aug. 14	J.	Checks and dirties from Wisconsin.	do.[5]	Aug. 13	Aug. 13 and 14	40	62	1	303	94	94	0	0	6	27	In sample can with sterile milk stirrer.	1	do	−10
76	do	H.	do	do.[6]	do	do	40	62	7							25	Large power churn	1	do	−10

[1] Sampled without warning; therefore, unbiased grading; eggs graded out, but considered too good for tanners, went into sample 22.

[2] Contained hatch spots, 49 per cent; broken yolks, 20 per cent; stale infertiles, 17 per cent; advanced hatch spots, 8 per cent; firm mottled yolks, 3 per cent; slightly stuck yolks, 1 per cent; moldy stuck yolks, 1 per cent; cloudy white, 1 per cent.

[3] Grading approved; contained hatch spots, 77 per cent; stale infertiles, 14 per cent; good broken yolks, 7 per cent; not classified, 2 per cent.

[4] Grading done before arrival of Bureau representatives at factory; therefore, unbiased. Taken from 540-pound batch.

[5] Contained light hatch spots, 56 per cent; broken yolks, 22 per cent; blood rings, 8 per cent; stale infertiles, 3 per cent; mottled yolks, 1 per cent; slightly mottled, 1 per cent; much mottled, 1 per cent; very soft, 1 per cent; unclassified, 1 per cent. One hatch spot had "off" odor.

[6] Sampled without warning; therefore, unbiased grading.

Sample No.	Date analyzed.	Initial of analyst.	Odor when analyzed.	Total solids (wet basis).	Ether extract (wet basis).	Ammonia nitrogen (wet basis).		Acidity of fat as N/20 sodium ethylate.	Reducing sugar as dextrose (wet basis).	Indol.	Skatol.	Physical examination.	Organisms per gram.				
						Titration.	Nesslerization.						Plain agar, 20° C., 120 hours.	Plain agar, 37° C., 48 hours.	Acid producers, 37° C., 48 hours.	Alkali producers, 37° C., 48 hours.	Confirmed *B. coli.*
	1917.			*Per.ct.*	*Per ct.*	*Mg. per 100 grams.*	*Mg. per 100 grams.*	*Cc. per gram.*	*P.ct.*								
21	Aug. 29	D.	Good....	29.06	11.66	2.2	2.5	1.95		0	0	Odor good; appearance good; color normal; temperature +1° C.					
		E.	...do.....	29.45	12.17	2.4	2.6	2.00	0.34	0	0						
		H.	...do.....	28.28	11.35	2.2	1.4	1.82	.29				1,800,000	1,100,000	0	0	1,000
		S.	...do.....	28.64	11.51	2.5	2.1	2.02	.29				1,500,000	1,400,000	0	0	1,000
			Average.	28.86	11.67	2.3	2.2	1.95	.31	0	0		1,650,000	1,300,000	0	0	1,000
40	Aug. 30	B.	Good....	27.77	10.95	2.5	2.9		.30	0	0	Odor good; appearance good; color normal; temperature 0° C.					
		E.	...do.....	28.06	10.93	2.4	2.5	1.74	.31	0	0						
		H.	...do.....	27.93	11.00	2.7	2.2	1.96	.27				5,300,000	2,900,000	77,000	250,000	10,000
		S.	...do.....	28.08	11.05	2.5	2.0	1.78	.33				5,300,000	2,800,000	83,000	270,000	10,000
			Average.	27.96	10.98	2.5	2.4	1.83	.30	0	0		5,300,000	2,900,000	80,000	260,000	10,000
43	....do....	B.	Good....	27.28	10.46	2.7	2.8		.31			Odor good; appearance good; color normal; temperature 0° C.					
		E.	...do.....	27.41	10.34	2.1	2.1	1.72	.32								
		H.	...do.....	26.91	10.35	2.0	1.3	1.77	.28	0	0		171,000	20,000	0	0	100
		S.	...do.....	27.57	10.65	2.4	1.9	1.81	.36	0	0		150,000	29,000	0	0	100
			Average.	27.29	10.45	2.3	2.0	1.77	.32	0	0		160,000	25,000	0	0	100
60	Sept. 4	B.	Good....	28.95	11.78	2.5	2.3	1.82	.32	0	0	Odor good; appearance good; color normal; temperature −2° C.	3,000,000	1,500,000	600,000	50,000	100,000
		D.	...do.....	29.30	11.92	3.0	3.1	1.78	.24	0	0						
		E.	...do.....	28.84	11.96	2.6	2.3	1.89	.31								
		H.	...do.....	28.56	11.46	3.0	2.6		.29				2,600,000	1,800,000	600,000	49,000	10,000
			Average.	28.91	11.78	2.8	2.6	1.77	.29	0	0		2,800,000	1,700,000	600,000	50,000	55,000

TABLE 9.—*Results of examination of frozen commercial first-grade whole egg containing no sugar or salt (grading observed and recorded in some)*—Con.

Sample No.	Date analyzed.	Initial of analyst.	Odor when analyzed.	Total solids (wet basis).	Ether extract (wet basis).	Ammonia nitrogen (wet basis).		Acidity of fat as N/20 sodium ethylate.	Reducing sugar as dextrose (wet basis).	Indol.	Skatol.	Physical examination.	Organisms per gram.				
						Titration.	Nesslerization.						Plain agar, 20° C., 120 hours.	Plain agar, 37° C., 48 hours.	Acid producers, 37° C., 48 hours.	Alkali producers, 37° C., 48 hours.	Confirmed *B. coli.*
	1917.			*Per ct.*	*Per ct.*	*Mg. per 100 grams.*	*Mg. per 100 grams.*	*Cc. per gram.*	*Per ct.*								
74	Sept. 4	B.	Good	27.57	10.83	2.4	2.4	1.77	0.29			Odor good; appearance good; color normal; temperature −2° C.	1,200,000	1,000,000	640,000	18,000	1,000
		D.	do	27.84	11.36	2.6	2.3	1.70	.32								
		E.	do	27.59	10.73	2.4	2.1	1.66	.29								
		H.	do	27.41	10.80	2.7	2.0	1.78	.31								
		S.								0	0		1,500,000	1,200,000	680,000	22,000	1,000
			Average	27.60	10.93	2.5	2.2	1.73	.30	0	0		1,400,000	1,100,000	660,000	20,000	1,000
76	Sept. 5	B.								0	0	Odor good; appearance good; color normal; temperature −2° C.					
		D.	Good	28.95	12.21	2.2	[1]4.2	1.71	.32								
		E.	do	29.11	11.73	2.4	2.3						4,200,000	2,000,000	590,000	220,000	100,000
		H.	do	28.74	11.55	2.9	2.7	1.69	.30								
		S.	do	28.50	11.37	2.8	2.7	1.89	.33				4,500,000	2,800,000	530,000	210,000	1,000,000
			Average[2]	28.83	11.72	2.6	2.6	1.76	.32	0	0		4,400,000	2,400,000	560,000	210,000	550,000
Grand average[2]				28.24	11.26	2.5	2.3	1.82	.31	0	0		2,600,000	1,600,000	320,000	90,000	100,000
Maximum[2]				28.91	11.78	2.8	2.6	1.95	.32	0	0		5,300,000	2,900,000	660,000	260,000	550,000
Minimum[2]				27.29	10.45	2.3	2.0	1.73	.29	0	0		160,000	25,000	0	0	100

[1] Cloudy solution interfered with nesslerization.

[2] Abnormal figure for ammonia nitrogen content of sample 76 omitted.

Formula values: Sample 21 = −7.12; sample 40 = −3.70; sample 43 = −5.72; sample 60 = −3.17; sample 74 = −5.16; sample 76 = −4.67.

TABLE 10.—*Results of examination of frozen commercial first-grade whole egg containing 1 per cent sugar and 0.7 per cent salt (grading observed in some).*

Sample No.	Date prepared.	Initial of investigator.	Eggs in shell.					Temperature of breaking room.	Number of breakers.	Size of sample.	How churned.	Time consumed in preparing sample.	Odor when put in freezer.	Temperature of freezer.
			Previous history.	Kind of eggs.	Date received.	Date candled.	Temperature of holding room.							
	1917.				1917.	1917.	*° F.*	*° F.*		*Pounds.*		*Hours.*		*° F.*
4	Apr. —	H.	Unknown	Unknown[1]						30	Large power churn			
9	Aug. 3	H.	do	do.[2]						30	do			
11	Aug. 6	R.	Cracks from Fort Dodge, Iowa.	Cracks[3]	Aug. 2	Aug. 6	35	63	16	25	do	½	Good	+1
18	Aug. 7	H.	Current receipts from Oklahoma.	Current receipts.[4]	July 27	Aug. 7	35	63	16	25	do	½	do	+1
50	Aug. 10	J.	Cracks from June storage pack and Mt. Vernon, Ill.	Cracks[5]	Aug. 4 and 6	Aug. 4 and 6	36	62	5	25	do	¾	do	−7

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[1] First-grade, April pack. Purchased in August.

[2] First-grade packed commercially three days before investigation began.

[3] From 150-pound batch. Contained about 70 per cent hatch spots and 30 per cent infertiles.

[4] Pretended to be through sampling and then took this one for unbiased grading. Contained mostly hatch spots, few weak, many blood rings, and some small embryos.

[5] Grading was not observed by Bureau representatives. Compare with results from dictated grading, using same eggs.

TABLE 10.—*Results of examination of frozen commercial first-grade whole egg containing 1 per cent sugar and 0.7 per cent salt (grading observed in some)*—Continued.

Sample No.	Date analyzed.	Initial of analyst.	Odor when analyzed.	Total solids (wet basis).	Ether extract (wet basis).	Ammonia nitrogen (wet basis).		Acidity of fat as N/20 sodium ethylate.	Reducing sugar as dextrose (wet basis).	Indol.	Skatol.	Physical examination.	Organisms per gram.				
						Titration.	Nesslerization.						Plain agar, 20° C., 120 hours.	Plain agar, 37° C., 48 hours.	Acid producers, 37° C., 48 hours.	Alkali producers, 37° C., 48 hours.	Confirmed *B. coli.*
				Per ct.	*Per ct.*	*Mg. per 100 grams.*	*Mg. per 100 grams.*	*Cc. per gram.*	*Per ct.*								
4	1917. Aug. 25	B.	Good	28.44	10.29	2.0	1.8	1.51	[1] 0.38	0	0	Odor good; appearance good; color normal; temperature, −2° C.	360,000	30,000	...	...	100
		D.	...do	28.11	10.10	1.8	1.9	2.00	.27	0	0						
		H.	...do	27.36	9.56	2.0	1.5	1.55	.33	...	...	...	...	...	...	...	...
		S.	...do	26.93	9.68	1.4	2.0	1.67	.29	...	...	...	320,000	10,000	...	...	100
			Average[2].	27.71	9.91	1.8	1.8	1.68	.30	0	0	...	340,000	20,000	...	...	100
9	...do	B.	Good	27.54	10.90	2.7	2.4	1.62	.30	...	...	Odor good; appearance good; color normal; temperature, −2° C.	15,500,000	5,000,000	...	...	100,000
		D.	...do	29.13	11.54	2.2	2.6	...	...	...	...						
		H.	...do	29.52	11.65	2.3	2.5	1.69	.29	...	...	...	...	...	...	...	...
		S.	...do	29.39	11.83	...	2.5	1.76	.25	0	0	...	14,500,000	6,700,000	...	...	100,000
			Average.	28.90	11.48	2.4	2.5	1.69	.28	0	0	...	15,000,000	5,900,000	...	...	100,000
11	Aug. 24	B.	Good	29.37	11.04	2.6	2.9	1.90	.32	0	0	Odor good; temperature, −2° C.; blood rings; no embryos or molds.	...	...	...	...	...
		E.	...do	28.97	10.56	2.2	3.0	1.71	.30	0	0						
		H.	...do	29.30	11.05	2.6	3.2	1.77	.31	...	...	...	7,000,000	2,600,000	...	...	10,000
		S.	...do	29.04	10.68	2.6	2.2	2.01	.30	...	...	...	8,500,000	2,700,000	...	...	10,000
			Average.	29.20	10.83	2.5	2.8	1.90	.31	0	0	...	7,800,000	2,700,000	...	...	10,000
18	Aug. 22	B.	Good	29.61	11.15	2.4	[3] 3.4	1.69	.31	0	0	Odor strong; appearance good; color normal; temperature, 0° C.	...	...	...	...	...
		D.	...do	29.79	11.58	[4] 3.1	2.9	1.80	.28	0	0						
		E.	...do	28.90	10.87	2.3	2.4	1.77	.28	0	0	...	...	...	...	...	...
		H.	...do	28.59	...	2.0	2.4	...	.31	0	0	...	2,700,000	200,000	...	...	10,000
		S.	...do	29.96	11.14	2.3	2.7	1.95	.29	0	0	...	3,000,000	400,000	...	...	10,000
			Average[2].	29.37	11.19	2.3	2.6	1.80	.29	0	0	...	2,900,000	300,000	...	...	10,000

50	Sept. 1	B.	Fair.....	29.10	11.10	2.7	1.7	1.65	.31	0	0	Odor good; appearance good; temperature, 0° C.	....	....	....	....	....
		D.	Good....	29.50	11.40	2.3	....	1.64	.26	0	0						
		E.	....	29.42	11.11	2.2	2.2	1.80	.30	......	......	....	6,100,000	1,400,000	750,000	0	1,000,000
		S.	Good....	28.65	10.46	2.4	2.2	1.57	.32	......	......	....	6,500,000	2,600,000	900,000	0	1,000,000
			Average	29.17	11.02	2.4	2.0	1.67	.30	0	0	....	6,300,000	2,000,000	850,000	0	1,000,009 0
Grand average[2]............				28.89	10.89	2.3	2.4	1.75	.30	0	0	....	6,500,000	2,200,000	850,000 ?	0	220,000
Maximum[2]............				29.37	11.48	2.5	2.8	1.90	.31	0	0	....	15,000,000	5,850,000	850,000	0	1,000,000
Minimum[2]............				27.71	9.91	1.8	1.8	1.67	.28	0	0	....	340,000	20,000	850,000	0	100

[1] Crucible not completely dried. [2] Abnormal figures omitted. [3] Cloudy solution interfered with nesslerization. [4] Alkali carried over mechanically.

Formula values; Sample 4= —10.29; sample 9= —3.63; sample 11= —2.20; sample 18= —6.31; sample 50= —3.82.

TABLE 11.—*Results of examination of frozen experimental soft-grade whole egg containing no sugar or salt (grading dictated).*

Sample No.	Date prepared.	Initial of investigator.	Eggs in shell.					Eggs in breaking room.								Size of sample.	How churned.	Time consumed in preparing sample.	Odor when put in freezer.	Temperature of freezer.
											Distribution.									
			Previous history.	Kind of eggs.	Date received.	Date candled.	Temperature of holding room.	Temperature of breaking room.	Number of breakers.	Number of eggs graded.	Used in sample.	As first grade.	As soft grade.	As second grade.	As tanner grade.					
	1917.				1917.	1917.	*F.*°	*F.*°			*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Lbs.*		*Hrs.*		° *F.*
31	Aug. 9	R.	Current receipts from Jacksonville, Ill.	Graded out from case pack.[1]	Aug. 4	Aug. 9	37	74	2	......	......	......	......	......	......	23	Small power churn.	3	Good.....	—5
47	Aug. 10	R.	Cracks from June case pack and current receipts from Mount Vernon, Ill.	Cracks and current receipts.[2]	Aug. 4 Aug. 6	Aug. 4 Aug. 6	36	62	1	......	......	......	......	......	......	11	In sample can with sterile milk stirrer.	3	.....do....	—7
65	Aug. 13	J.	Checks and dirties from Iowa.	Checks and dirties.[3]	Aug. 8 and 11	Aug. 11 and 13	40	66	1	581	26	57	26	16	1	14	.....do............	2	.....do....	—10
71	Aug. 14	R.	Cracks and dirties from Wisconsin.	Cracks and dirties.[4]	Aug. 13	Aug. 13 and 14	40	66	1	1,265	37	45	37	12	6	26	.....do............	4	.....do....	—10

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[1] Included advanced hatch spots, 47 per cent; weak, 45 per cent; dark yolks, 8 per cent.

[2] Included weak with yolks slightly broken, 79 per cent; mottled firm yolks, 10 per cent; advanced hatch spots, 10 per cent; chocolate yolk, 1 per cent.

[3] Graded out from sample 64. Included 4 per cent of slightly mottled yolks; balance typical weak eggs, stale infertiles and hatch spots, showing no blood.

[4] Graded out from sample 70. Included weak, 71 per cent; mottled firm yolks (heated), 19 per cent; advanced hatch spots, 6 per cent; stale, 2 per cent; dark yolks, 1 per cent; sour, 1 per cent.

TABLE 11.—*Results of examination of frozen experimental soft-grade whole egg containing no sugar or salt (grading dictated)*—Continued.

Sample No.	Date analyzed.	Initial of analyst.	Odor when analyzed.	Total solids (wet basis).	Ether extract (wet basis).	Ammonia nitrogen (wet basis).		Acidity of fat as N/20 sodium ethylate.	Reducing sugar as dextrose (wet basis).	Indol.	Skatol.	Physical examination.	Organisms per gram.				
						Titration.	Nesslerization.						Plain agar, 20° C., 120 hours.	Plain agar, 37° C., 48 hours.	Acid producers, 37° C., 48 hours.	Alkali producers, 37° C., 48 hours.	Confirmed *B. coli.*
	1917.			*Per ct.*	*Per ct.*	*Mg. per 100 grams.*	*Mg. per 100 grams.*	*Cc. per gram.*	*Per ct.*								
31	Aug. 28	B.	Good....	27.46	10.79	2.5	2.5	1.96	0.28	0	0	Odor good; appearance good; color normal; temp. 0° C.	9,100,000	2,400,000	99,000	0	100,000
		D.	Strong...	27.46	10.88	2.1	2.3	....	.28	0	0						
		E.	Good....	28.05	10.96	2.2	2.4	1.70	.30	0	0	....					
		H.	...do.....	27.51	10.83	....	1.7	1.81	....	0	0		9,400,000	2,200,000	100,000	0	100,000
			Average.	27.62	10.87	2.3	2.2	1.82	.29	0	0	....	9,300,000	2,300,000	100,000	0	100,000
47	Aug. 31	B.	Fair.....	28.54	11.46	2.2	1.9	1.85	.31	0	0	Odor good; appearance good; color normal; temp. +1° C.	340,000	90,000	57,000	10,000	1,000
		D.	Good....	27.25	11.38	2.3	2.2	....	.27	0	0						
		H.	...do.....	27.75	11.13	2.1	1.8	....	.25	0	0	....					
		S.	...do.....	27.75	10.91	2.1	2.0	1.82	.30	0	0		290,000	120,000	63,000	10,100	100
			Average.	27.82	11.22	2.2	2.0	1.84	.28	0	0	....	320,000	110,000	60,000	10,000	550
65	Sept. 5	D.	Slightly sour.	26.95	10.52	2.3	[1]5.3	1.94	.31	0	0	Odor strong; appearance good; color normal; temp. −2° C.	....	....	....	....	....
		E.	Good....	27.17	10.78	2.3	2.4	1.76	.32	0	0						
		H.	...do.....	27.21	10.50	2.8	1.9	....	.30	0	0	....	....	....	....	....	....
		S.	...do.....	27.70	10.81	2.6	2.8	1.81	.36	0	0						
			Average[2].	27.26	10.65	2.5	2.4	1.84	.32	0	0	....	(3)	(3)	(3)	....	(3)
71	Sept. 6	B.	Strong...	28.21	11.01	2.5	1.9	1.90	.30	0	0	Odor good; appearance good; color normal; temp. −1° C.	....	....	....	....	....
		E.	Good....	28.11	11.25	2.1	2.5	1.95	.30	0	0						
		H.	...do.....	27.59	10.92	2.5	2.4	1.73	....	0	0	....	1,400,000	210,000	130,000	0	100,000
		S.	...do.....	27.22	10.73	2.4	2.4	1.70	.31	0	0	....	1,200,000	120,000	130,000	0	100,000
			Average.	27.78	10.98	2.4	2.3	1.82	.30	0	0	....	1,300,000	170,000	130,000	0	100,000

Grand average[2]	27.62	10.93	2.3	2.2	1.83	.30	0	0	....	3,600,000	850,000	97,000	3,000	67,000
Maximum[2]	27.82	11.22	2.5	2.4	1.84	.32	0	0	....	9,300,000	2,300,000	130,000	10,000	100,000
Minimum[2]	27.26	10.65	2.1	2.0	1.82	.28	0	0	....	320,000	110,000	60,000	0	550

[1] Cloudy solution interfered with nesslerization.
[2] Abnormal figures omitted.
[3] Sample contaminated.

Formula values: Sample 31= −4.17; sample 47= −7.33; sample 65= −4.21+; sample 71= −6.29.

TABLE 12.—*Results of examination of frozen commercial soft-grade whole egg containing no sugar or salt (grading observed and recorded in some).*

Sample No.	Date prepared.	Initial of investigator.	Eggs in shell.					Eggs in breaking room.								Size of sample.	How churned.	Time consumed in preparing sample.	Odor when put in freezer.	Temperature of freezer.
											Distribution.									
			Previous history.	Kind of eggs.	Date received.	Date candled.	Temperature of holding room.	Temperature of breaking room.	Number of breakers.	Number of eggs graded.	Used in sample.	As first grade.	As soft grade.	As second grade.	As tanner grade.					
							°F.	°F.			P.ct.	P.ct.	P.ct.	P.ct.	P.ct.	Lbs.		Hrs.		°F.
13	1917. Aug. 7	R.	Current receipts from Oklahoma.	Current receipts.[1]	1917. July 27	1917. Aug. 7	35	63	4	804	17	77	17	0	6	24	Small hand churn.	2	Good.....	+1
45	Aug. 10	J.	Cracks from June case packs and current receipts from Mount Vernon, Ill.	Cracks and current receipts[2].	Aug. 4 and 6	Aug. 4 and 6	36	62	2	635	5	89	5	3	3	8½	In sample can with sterile milk stirrer.	4	...do.....	−7
54	Apr.—	H.	Unknown.	Unknown.[3]	....	....	....	....	....	....	....	....	....	....	....	30	....	....	....	....

[1] Graded out from samples 12 and 17. Contained weak yolks, 38 per cent; heavily mottled yolks, 31 per cent; hatch spots, 20 per cent; blood rings, 6 per cent; stale infertiles, 5 per cent.

[2] Graded out from samples 42 and 44. Contained weak yolks, 40 per cent; mottled yolks and cloudy whites, 34 per cent; broken yolks, 12 per cent; firm yolks, 8 per cent; yolks broken by accident, 4 per cent; slightly stuck, 2 per cent.

[3] Soft-grade April pack. Purchased in August.

TABLE 12.—*Results of examination of frozen commercial soft-grade whole egg containing no sugar or salt (grading observed and recorded in some)*—Con.

Sample No.	Date analyzed.	Initial of analyst.	Odor when analyzed.	Total solids (wet basis).	Ether extract (wet basis).	Ammonia nitrogen (wet basis).		Acidity of fat as N/20 sodium ethylate.	Reducing sugar as dextrose (wet basis).	Indol.	Skatol.	Physical examination.	Organisms per gram.				
						Titration.	Nesslerization.						Plain agar, 20° C., 120 hours.	Plain agar, 37° C., 48 hours.	Acid producers, 37° C., 48 hours.	Alkali producers, 37° C., 48 hours.	Confirmed *B. coli.*
	1917.			*Per. ct.*	*Per ct.*	*Mg. per 100 grams.*	*Mg. per 100 grams.*	*Cc. per gram.*	*Per ct.*								
13	Aug. 24	B.	Good....	26.13	10.02	2.6	2.6	....	0.29	......	......	Odor good; appearance good; color normal; temperature −2° C.					
		E.	...do....	25.21	9.45	2.1	2.7	1.77	.25	0	0		......	......	......	......	......
		H.	...do....	26.02	10.08	2.4	1.8	1.79	.26	0	0	......	900,000	950,000	......	......	100,000
		S.	...do....	25.86	9.77	2.4	1.8	1.97	.27	0	0	......	1,100,000	1,100,000	......	......	10,000
			Average.	25.81	9.83	2.4	2.2	1.84	.27	0	0	......	1,000,000	1,000,000	......	......	55,000
45	Aug. 31	B.	Fair.....	27.17	10.43	2.0	1.5	2.01	.33	0	0	Odor strong; appearance good; color normal; temperature +1° C.	3,400,000	4,900,000	0	0	100
		D.	Strong...	27.33	11.11	2.5	2.4	....	.31	0	0						
		H.	Good....	27.51	10.81	2.5	2.2	....	......	......	......	......	......	......	......	......	......
		S.	...do....	27.39	10.28	2.6	2.1	1.97	.34	......	......	......	4,100,000	4,500,000	0	0	100
			Average.	27.35	10.66	2.4	2.1	1.99	.33	0	0	......	3,800,000	4,700,000	0	0	100
54	Sept. 1	B.	Fair.....	27.71	10.78	2.2	1.5	1.61	.35	......	......	Odor good; appearance good; color normal; temperature 0° C.	150,000	100,000	10,000	0	100
		D.	Good....	27.01	10.30	....	2.0	1.73	28	......	......						
		E.	....	27.51	10.60	1.7	1.8	1.83	.32								
		H.	Fair.....	......	......	......	......	......	......	0	0	......	......	......	......	......	......
		S.	Good....	26.86	9.75	2.2	1.8	1.76	.31	......	......	......	110,000	80,000	10,000	0	100
			Average.	27.27	10.36	2.0	1.8	1.73	.32	0	0	......	130,000	90,000	10,000	0	100
Grand average..........				26.81	10.28	2.3	2.0	1.85	.31	0	0	......	1,600,000	1,900,000	5,000	0	18,500
Maximum..........				27.35	10.66	2.4	2.2	1.99	.33	0	0	......	3,800,000	4,700,000	10,000	0	55,000
Minimum..........				25.81	9.83	2.0	1.8	1.73	.27	0	0	......	130,000	90,000	0	0	100

Formula values: Sample 13= −1.44; sample 45= −3.28; sample 54= −9.88.

TABLE 13.—*Results of examination of frozen whole egg prepared from leakers containing no sugar or salt.*

Sample No.	Date prepared.	Initial of investigator.	Eggs in shell.					Eggs in breaking room.								Size of sample.	How churned.	Time consumed in preparing sample.	Odor when put in freezer.	Temperature of freezer.
			Previous history.	Kind of eggs.	Date received.	Date candled.	Temperature of holding room.	Temperature of breaking room.	Number of breakers.	Number of eggs graded.	Distribution.									
											Used in sample.	As first grade.	As soft grade.	As second grade.	As tanner grade.					
	1917.				1917.	1917.	° F.	° F.			*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*Lbs.*		*Hrs.*		° F.
1	Aug. 6	R.	Cracks from Fort Dodge, Iowa.	Leakers graded out from cracks by 1 candler.[1]	Aug. 2	Aug. 6	35	....	1	......	......	......	......	......	......	24	In small hand churn.	4	Good	+1
3	...do....	J.	.....do..........	Leakers graded out from cracks by 6 candlers.[2]	...do....	..do.....	35	63	2	360	74	74	0	8	18	22	.....do..........	1½	...do.....	+1
30	Aug. 9	J.	Current receipts from Jacksonville, Ill.	Leakers graded out from current receipts by whole candling force.[3]	Aug. 4	Aug. 9	37	74	1	360	80	80	0	8	12	23	In small power churn.	2	...do.....	—5
49	Aug. 10	J.	Cracks from June case pack and current receipts from Mount Vernon, Ill.	Leakers graded out from cracks and current receipts by candlers.[4]	Aug. 4 and 6	Aug. 4 and 6	36	....	....	......	......	......	......	......	......	24	In sample can with sterile milk stirrer.	1	Musty ...	—7

[1] Broken out in candling room as breaker candled cracks. Bad eggs detected by candling or smell discarded. Breaking and grading done very carefully.

[2] Broken out in breaking room under best conditions. Grading observed. Breaking room discards included moldy, 58 per cent; sour, 12 per cent; mixed rots, 10 per cent; slightly stuck yolks, 9 per cent; green whites, 7 per cent; strong odor, 2 per cent; empty, 2 per cent.

[3] Broken out in breaking room under best conditions. Grading dictated. Fifty-three per cent of the breaking-room discards were moldy.

[4] Broken out directly into cans in candling room by candlers with no other grading than candling.

TABLE 13.—*Results of examination of frozen whole egg prepared from leakers containing no sugar or salt*—Continued.

Sample No.	Date analyzed.	Initial of analyst.	Odor when analyzed.	Total solids (wet basis).	Ether extract (wet basis).	Ammonia nitrogen (wet basis).		Acidity of fat as N/20 sodium ethylate.	Reducing sugar as dextrose (wet basis).	Indol.	Skatol.	Physical examination.	Organisms per gram.				
						Titration.	Nesslerization.						Plain agar, 20° C., 120 hours.	Plain agar, 37° C., 48 hours.	Acid producers, 37° C., 48 hours.	Alkali producers, 37° C., 48 hours.	Confirmed *B. coli*.
				Per ct.	*Per ct.*	*Mg. per 100 grams.*	*Mg. per 100 grams.*	*Cc. per gram.*	*Per. ct.*								
	1917.																
1	Aug. 23	D.	Strong...	29.91	12.47	......	......	......	......	0	0	Odor strong; appearance good; color normal; temperature, −2° C.	......	......	......	......	......
		E.	...do.....	30.77	12.85	2.2	2.7	1.50	0.31	0	0						
		H.	Good....	30.39	12.63	2.0	2.7	......	.27	0	0	......	13,600,000	2,300,000	......	......	100,000
		S.	...do.....	29.25	12.90	2.4	3.2	1.69	.32	0	0	......	11,900,000	1,400,000	......	......	100,000
			Average.	30.08	12.71	2.2	2.9	1.60	.30	0	0	......	12,800,000	1,900,000	......	......	100,000
3	...do....	D.	Good. Sl.	28.78	11.75	2.9	3.4	......	......	0	0	Odor strong; appearance good; color normal; temperature, −2° C.	......	......	......	......	......
		E.	strong...	29.03	11.50	2.4	2.5	1.51	.32	0	0						
		H.	Good....	28.36	11.46	2.6	2.5	......	......	0	0	......	8,900,000	2,700,000	......	......	100,000
		S.	...do.....	28.55	12.41	2.4	3.1	1.67	.28	0	0	......	9,700,000	2,400,000	......	......	100,000
			Average.	28.68	11.78	2.6	2.9	1.59	.30	0	0	......	9,300,000	2,600,000	......	......	100,000
30	Aug. 28	B.	Good....	30.11	12.49	2.9	2.1	1.72	.28	......	......	Odor good; appearance good; color normal; temperature, 0° C.	......	......	......	......	......
		D.	Strong...	30.01	12.58	2.3	2.4	......	......	......	......						
		E.	Good....	30.87	12.71	2.5	3.3	1.70	.27	0	0	......	1,900,000	1,300,000	4,800	0	1,000
		H.	...do.....	30.22	12.70	......	2.0	1.79	......	0	0	......	2,000,000	1,300,000	5,100	0	1,000
			Average.	30.30	12.62	2.6	2.5	1.74	.28	0	0	......	2,000,000	1,300,000	5,000	0	1,000
49	Sept. 1	B.	Musty...	28.93	11.75	2.6	1.9	1.77	.32	0	0	Odor musty; appearance good; temperature, 0° C.	......	......	......	......	......
		D.	...do.....	29.79	12.46	2.9	3.3	1.74	.24	0	0						
		E.	...do.....	28.59	11.14	2.7	2.7	1.94	.29	0	0	......	10,400,000	600,000	100,000	0	100
		S.	...do.....	29.68	12.03	2.8	2.5	1.90	.33	......	......	......	10,400,000	1,300,000	99,000	0	100
			Average.	29.25	11.85	2.8	2.6	1.84	.30	0	0	......	10,400,000	950,000	100,000	0	100

Grand average	29.58	12.24	2.6	2.7	1.69	.30	0	0		8,800,000	1,700,000	53,000	0	50,000
Maximum	30.30	12.71	2.8	2.9	1.84	.30	0	0		12,800,000	2,600,000	100,000	0	100,000
Minimum	28.68	11.78	2.2	2.5	1.59	.28	0	0		2,000,000	950,000	5,000	0	100

Formula values: Sample 1= —11.29; sample 3= —5.94; sample 30 = —7.78; sample 49= —1.76.

TABLE 14.—*Results of examination of frozen experimental first-grade yolk containing no sugar (grading dictated).*

Sample No.	Date prepared.	Initial of investigator.	Eggs in shell.					Eggs in breaking room.								Size of sample.	How churned.	Time consumed in preparing sample.	Odor when put in freezer.	Temperature of freezer.
			Previous history.	Kind of eggs.	Date received.	Date candled.	Temperature of holding room.	Temperature of breaking room.	Number of breakers.	Number of eggs graded.	Distribution.									
											Used in sample.	As first grade.	As soft grade.	As second grade.	As tanner grade.					
	1917.				1917.		°F.	°F.			P.ct.	P.ct.	P.ct.	P.ct.	P.ct.	Lbs.		Hrs.		°F.
17	Aug. 7	J.	Current receipts from Oklahoma.	Current receipts[1]	July 27	Aug. 7	35	63	2	......	......	......	......	......	......	26	Small hand churn.	2	Good.....	+1
44	Aug. 10	J.	From June storage pack and from Mount Vernon, Ill.	Cracks[2]...........	Aug. 4,6	Aug. 4,6	36	62	1	635	89	89	5	3	3	25	In can with sterile milk stirrer.	3	...do.....	—7

[1] Weak eggs graded out went into sample 13.

[2] Contained 76 per cent hatch spots, 18 per cent infertiles, and 6 per cent unclassified.

TABLE 14.—*Results of examination of frozen experimental first-grade yolk containing no sugar (grading dictated)*—Continued.

Sample No.	Date analyzed.	Initial of analyst.	Odor when analyzed.	Total solids (wet basis).	Ether extract (wet basis).	Ammonia nitrogen (wet basis). Titration.	Ammonia nitrogen (wet basis). Nesslerization.	Acidity of fat as N/20 sodium ethylate.	Reducing sugar as dextrose (wet basis).	Indol.	Skatol.	Physical examination.	Organisms per gram. Plain agar, 20° C., 120 hours.	Organisms per gram. Plain agar, 37° C., 48 hours.	Organisms per gram. Acid producers, 37° C., 48 hours.	Organisms per gram. Alkali producers, 37° C., 48 hours.	Organisms per gram. Confirmed *B. coli.*
	1917.			*Per ct.*	*Per ct.*	*Mg. per 100 grams.*	*Mg. per 100 grams.*	*Cc. per gram.*	*Per ct.*								
17	Aug. 24	B.	Good....	43.00	22.83	4.2	4.6	....	0.20	0	0	Odor good; appearance good; color normal: temperature −2° C.	....	....	....	....	....
		E.	...do.....	42.99	22.53	4.3	5.0	1.77	.20	0	0						
		H.	...do.....	43.80	23.15	3.7	2.7	1.79	.18	......	......	....	220,000	170,000	....	....	1,000
		S.	...do.....	43.89	23.59	4.0	3.2	1.86	.21	......	......	....	260,000	150,000	....	....	1,000
			Average.	43.42	23.03	4.1	3.9	1.81	.20	0	0	....	240,000	160,000	....	....	1,000
44	Aug. 30	B.	Good....	44.20	23.11	4.8	4.5	1.92	.19	......	......	Odor good; appearance good; color normal; temperature 0° C.	....	....	....	....	....
		D.	...do.....	....	....	....	....	....	....	0	0						
		E.	...do.....	44.19	23.45	4.0	4.2	1.78	.19	......	......	....	....	....	....	....	....
		H.	...do.....	40.47	23.45	4.7	4.9	1.79	.15	......	......	....	260,000	210,000	0	0	100
		S.	...do.....	43.90	22.97	4.2	3.4	1.70	.19	......	......	....	290,000	330,000	0	0	100
			Average.	43.19	23.25	4.4	4.3	1.80	.18	0	0	....	280,000	270,000	0	0	100
Grand average........				43.31	23.14	4.2	4.1	1.81	.19	0	0	....	260,000	220,000	0	0	550
Maximum........				43.42	23.25	4.4	4.3	1.81	.20	0	0	....	280,000	270,000	0	0	1,000
Minimum........				43.19	23.03	4.1	3.9	1.80	.18	0	0	....	240,000	160,000	0	0	100

Formula values: Sample 17= −14.57; sample 44= −11.30.

TABLE 15.—*Results of examination of frozen commercial first-grade yolk containing no sugar (grading observed or recorded).*

Sample No.	Date prepared.	Initial of investigator.	Eggs in shell.					Eggs in breaking room.								Size of sample.	How churned.	Time consumed in preparing sample.	Odor when put in freezer.	Temperature of freezer.
			Previous history.	Kind of eggs.	Date received.	Date candled.	Temperature of holding room.	Temperature of breaking room.	Number of breakers.	Number of eggs graded.	Distribution.									
											Used in sample.	As first grade.	As soft grade.	As second grade.	As tanner grade.					
	1917.				1917.	1917.	° *F.*	° *F.*			*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*Lbs.*		*Hrs.*		° *F.*
10	Aug. 6	R.	Cracks from Fort Dodge, Iowa.	Cracks[1]	Aug. 2	Aug. 6	35	63	16	......	.....	.....	.....	.....	.....	25	Large power churn.	$\frac{1}{2}$	Good....	+1
12	Aug. 7	R.	Current receipts from Oklahoma.	Current receipts[2]	July 27	Aug. 7	35	63	2	804	77	77	17	0	6	26	Small hand churn.	$2\frac{1}{2}$	...do.....	+1
20	Aug. 8	R.	Current receipts from Jacksonville, Ill.	Graded out from case pack.[3]	Aug. 4	Aug. 8	37	74	2	849	71	71	0	24	5	24	Small power churn.	$2\frac{1}{2}$	...do.....	−5
42	Aug. 10	R.	Cracks from June storage pack and from Mount Vernon, Ill.	Cracks[4]	Aug. 4 and 6	Aug. 4 and 6	36	6[illegible]	2	......	.....	.....	.....	.....	.....	25	In can with sterile milk stirrer.	2	...do.....	−7

[1] Contains 31 per cent infertiles and 69 per cent light hatch spots. Grading observed only. Breakers worked as usual.

[2] Graded commercially. Made from 42 per cent hatch spots, 40 per cent infertiles, 9 per cent blood rings, 5 per cent mottled yolks, and 4 per cent weak eggs.

[3] Graded commercially. Made from 44 per cent hatch spots, 40 per cent infertiles, 8 per cent blood rings, 4 per cent weak, 2 per cent mottled yolks, 1 per cent light stuck, and 1 per cent addled.

[4] Graded commercially. Made from 66 per cent hatch spots, 21 per cent infertiles, 8 per cent advanced hatch spots, 4 per cent mottled yolks, and 1 per cent weak.

TABLE 15.—*Results of examination of frozen commercial first-grade yolk containing no sugar (grading observed or recorded)*—Continued.

Sample No.	Date analyzed.	Initial of analyst.	Odor when analyzed.	Total solids (wet basis).	Ether extract (wet basis).	Ammonia nitrogen (wet basis).		Acidity of fat as N/20 sodium ethylate.	Reducing sugar as dextrose (wet basis).	Indol.	Skatol.	Physical examination.	Organisms per gram.				
						Titration.	Nesslerization.						Plain agar, 20° C., 120 hours.	Plain agar, 37° C., 48 hours.	Acid producers, 37° C., 48 hours.	Alkali producers, 37° C., 48 hours.	Confirmed *B. coli.*
				Per. ct.	*Per ct.*	*Mg. per 100 grams.*	*Mg. per 100 grams.*	*Cc. per gram.*	*Per. ct.*								
10	1917. Aug. 24	B.	Strong...	42.93	22.37	4.1	4.7	2.05	0.22	0	0	Odor good; appearance good; color normal; temperature, −2° C.	....	....	....	....	....
		E.	Good....	43.29	22.52	4.2	4.5	1.84	.16	0	0						
		H.	...do.....	43.12	22.14	4.2	4.3	2.10	.23	......	......	....	5,500,000	2,400,000	....	....	100,000
		S.	...do.....	43.04	21.69	4.1	3.8	1.87	.20	......	......	....	5,000,000	2,000,000	....	....	100,000
			Average.	43.10	22.18	4.2	4.3	1.97	.20	0	0	....	5,300,000	2,200,000	....	....	100,000
12	...do....	B.	Fair.....	44.12	23.81	4.2	4.4	....	.20	......	......	Odor good; appearance good; color normal; temperature, −2° C.	....	....	....	....	....
		E.	Good....	43.48	23.03	4.2	4.7	1.68	.19	......	......						
		H.	...do.....	44.54	21.42	4.2	2.6	1.98	.19	0	0	....	320,000	90,000	....	....	100
		S.	...do.....	44.35	23.32	4.2	2.9	1.89	.19	0	0	....	220,000	180,000	....	....	100
			Average.	44.12	22.90	4.2	3.7	1.85	.19	0	0	....	270,000	140,000	....	....	100
20	Aug. 29	D.	Good....	44.51	23.42	4.2	5.1	1.93	.19	0	0	Odor good; appearance good; color normal; temperature, +1° C.	....	....	....	....	....
		E.	...do.....	46.69	24.17	3.9	4.0	2.11	.16	0	0						
		H.	...do.....	43.83	23.26	3.9	5.2	1.89	.17	......	......	....	3,100,000	1,100,000	....	....	1,000
		S.	...do.....	44.31	23.40	4.0	3.6	2.04	.14	......	......	....	2,900,000	1,200,000	....	....	1,000
			Average.	44.84	23.56	4.0	4.5	1.99	.17	0	0	....	3,000,000	1,200,000	....	....	1,000

42	Aug. 30	B.	Good....	44.73	23.59	4.4	4.8	1.92	.17	......	......	Odor good; appearance good; color normal; temperature, 0° C.	....	....	....	....	....
		E.	...do.....	45.07	23.68	4.1	4.2	1.75	.16	......	......						
		H.	...do.....	44.51	23.82	4.0	4.8	1.88	.16	0	0	....	1,700,000	380,000	....	....	10,000
		S.	...do.....	44.55	23.66	4.2	3.6	1.79	.19	0	0	....	1,400,000	360,000	....	....	1,000
			Average.	44.72	23.69	4.2	4.4	1.84	.17	0	0	....	1,600,000	370,000	....	....	5,500
Grand average..........				44.19	23.08	4.1	4.2	1.91	.18	0	0	....	2,500,000	1,000,000	....	....	26,500
Maximum..........				44.84	23.69	4.2	4.5	1.99	.20	0	0	....	5,300,000	2,200,000	....	....	100,000
Minimum..........				43.10	22.18	4.0	3.7	1.84	.17	0	0	....	270,000	140,000	....	....	100

Formula values: Sample 10= −9.82; sample 12= −13.24; sample 20= −14.24; sample 42= −14.11.

TABLE 16.—*Results of examination of frozen commercial first-grade yolk containing 10 per cent sugar.*

Sample No.	Date prepared.	Initial of investigator.	Eggs in shell.		Size of sample.	How churned.	Date analyzed.	Initial of analyst.	Odor when analyzed.	Total solids (wet basis).	Ether extract (wet basis).	Ammonia nitrogen (wet basis).		Acidity of fat as N/20 sodium ethylate.	Reducing sugar as dextrose (wet basis).	Indol.	Skatol.	Physical examination.	Organisms per gram.				
			Previous history.	Kind of eggs.								Titration.	Nesslerization.						Plain agar, 20° C., 120 hours.	Plain agar, 37° C., 48 hours.	Acid producers, 37° C., 48 hours.	Alkali producers, 37° C., 48 hours.	Confirmed *B. coli.*
					Lbs.					*Per ct.*	*Per ct.*	*Mg. per 100 gms.*	*Mg. per 100 gms.*	*Cc. per gram.*	*P.ct.*								
2	1917. Apr. –	H.	Unknown.	Unknown.[1]	30	Large power churn	1917. Aug. 25	B.	Good.	48.48	17.94	3.3	2.7	1.05	[2]0.36	0	0	Odor good; appearance good; color normal; temp. −2° C.	......	......	....	....	......
								D.	...do...	48.33	......	2.6	2.5	......	.30	0	0						
								H.	...do...	48.37	18.07	3.3	2.7	1.22	.29	...	...	......	300,000	28,000	....	....	1,000
								S.	...do...	48.65	17.82	......	3.9	.84	.25	...	...	......	140,000	12,000	....	....	1,000
									Average[4].	48.46	17.94	3.1	3.0	1.04	.28	0	0	......	220,000	20,000	....	....	1,000
5	Aug. 3	H.	...do......	do.[3]......	30	...do.	Aug. 25	B.	Good.	49.26	18.62	4.2	3.4	1.06	.26	...	...	Odor good; appearance good; color normal, temp. −2° C.	......	......	....	....	......
								D.	...do...	48.96	18.78	3.2	3.0	1.37	.29	...	...						
								H.	...do...	49.08	18.94	3.4	3.0	1.20	.26	...	...	......	1,000,000	420,000	....	....	10,000
								S.	...do...	48.92	18.27	3.9	3.2	1.14	.22	0	0	......	900,000	480,000	....	....	10,000
									Average..	49.06	18.65	3.7	3.2	1.19	.26	0	0	......	950,000	450,000	....	....	10,000
							Grand average[4]......			48.76	18.35	3.4	3.1	1.13	.27	0	0	......	600,000	240,000	....	....	5,500
							Maximum[4]......			49.06	18.65	3.7	3.2	1.19	.28	0	0	......	950,000	450,000	....	....	10,000
							Minimum[4]......			48.46	17.94	3.1	3.0	1.04	.26	0	0	......	220,000	20,000	....	....	1,000

[1] First grade April pack; purchased in August.

[2] Crucible not completely dried.

[3] First grade August pack. Prepared three days before investigation began.

[4] Omitting abnormal figure.

Formula values: Sample 2= −14.55; sample 5= −8.54.

TABLE 17.—*Results of examination of frozen experimental second-grade whole egg containing no sugar or salt (grading dictated).*

Sample No.	Date prepared.	Initial of investigator.	Eggs in shell.					Eggs in breaking room.								Size of sample.	How churned.	Time consumed in preparing sample.	Odor when put in freezer.	Temperature of freezer.
			Previous history.	Kind of eggs.	Date received.	Date candled.	Temperature of holding room.	Temperature of breaking room.	Number of breakers.	Number of eggs graded.	Distribution.									
											Used in sample.	As first grade.	As soft grade.	As second grade.	As tanner grade.					
	1917.				1917.	1917.	°*F.*	°*F.*			*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*Lbs.*		*Hrs.*		°*F.*
32	Aug. 9	R.	Current receipts from Jacksonville, Ill.	Graded out from case pack.[1]	Aug. 4	Aug. 9	37	74	2	......	......	......	......	......	......	15	In small power churn.	3	Slightly sour.	−5
48	Aug. 10	R.	Cracks from June case pack and current receipts from Mount Vernon, Ill.	Cracks and current receipts.[2]	Aug. 4 and 6	Aug. 4 and 6	36	62	1	......	......	......	......	......	......	5	In sample can with sterile milk stirrer.	3	....	−7
66	Aug. 13	J.	Checks and dirties from Iowa.	Checks and dirties[3]	Aug. 8 and 11	Aug. 11 and 13	40	66	1	581	16	57	26	16	1	10	.....do.............	2	Sour......	−10
72	Aug. 14	R.	Cracks and dirties from Wisconsin.	Cracks and dirties[4]	Aug. 13	Aug. 13 and 14	40	62	1	1,265	12	45	37	12	6	14	.....do.............	4	Strong.....	−10

[1] Graded out from samples 29 and 31. Included very weak, mottled, and doubtful eggs.

[2] Graded out from samples 46 and 47. Included very weak yolks, 42 per cent; mottled yolks, 34 per cent; not classified, 13 per cent; cloudy whites, 9 per cent; advanced hatch spots, 2 per cent.

[3] Graded out from samples 64 and 65. Included slightly stuck yolks, 33 per cent; very mottled yolks, 20 per cent; very weak, 13 per cent; sour, 10 per cent; good whites (yolks discarded), 8 per cent; moldy cracks with normal contents, 5 per cent; blood rings, 5 per cent; mixed rots (early stage), 4 per cent; light green whites, 2 per cent.

[4] Graded out from samples 70 and 71. Included very weak, 51 per cent; heavily mottled yolks, 23 per cent; cloudy whites, 12 per cent; blood rings (bleached), 7 per cent; strong stale odor, 6 per cent; sour, 1 per cent.

TABLE 17.—*Results of examination of frozen experimental second-grade whole egg containing no sugar or salt (grading dictated)*—Continued.

Sample No.	Date analyzed.	Initial of analyst.	Odor when analyzed.	Total solids (wet basis).	Ether extract (wet basis).	Ammonia nitrogen (wet basis).		Acidity of fat as N/20 sodium ethylate.	Reducing sugar as dextrose (wet basis).	Indol.	Skatol.	Physical examination.	Organisms per gram.				
						Titration.	Nesslerization.						Plain agar, 20° C., 120 hours.	Plain agar, 37° C., 48 hours.	Acid producers, 37° C., 48 hours.	Alkali producers, 37° C., 48 hours.	Confirmed *B. coli.*
	1917.			*Per. ct.*	*Per ct.*	*Mg. per 100 grams.*	*Mg. per 100 grams.*	*Cc. per gram.*	*Per. ct.*								
32	Aug. 28	B.	Fair	27.53	10.56	2.2	2.4	1.92	0.31	.....	.....	Odor strong; appearance good; color normal; temperature, 0° C.	.....	.....	.....	.....	.....
		D.	Strong	27.63	10.78	2.3	2.2	.....	.30	.....	.....		.....	.....	.....	.....	.....
		E.	Good	28.15	10.65	2.0	2.2	1.72	.30	.....	.....	.....					
		H.	...do	27.48	10.52	.....	.....	1.81	.....	.....	.....	.....	4,100,000	4,000,000	1,000,000	0	100
		S.	.....	.....	.....	.....	.....	.....	.....	0	0	.....	4,100,000	3,500,000	1,000,000	0	100
			Average.	27.70	10.63	2.2	2.2	1.82	.30	0	0	.....	4,100,000	3,800,000	1,000,000	0	100
48	Aug. 31	B.	Fair	27.86	10.65	2.8	2.1	1.82	.32	.....	.....	Odor strong; melted [1]	.....	.....	.....	.....	.....
		D.	Good	27.69	11.33	3.0	3.3	2.12	.30	.....	.....	.....	.....	.....	.....	.....	.....
		H.	...do	27.91	10.96	2.7	3.0	.....	.30	0	0	.....	.....	.....	.....	.....	.....
		S.	...do	27.67	10.49	3.2	2.6	1.91	.31	0	0	.....	.....	.....	.....	.....	.....
			Average.	27.78	10.86	2.9	2.8	1.95	.31	0	0	.....	.....	.....	.....	.....	.....
66	Sept. 5	D.	Fair	26.91	.....	3.3	[2] 3.9	1.66	.27	.....	.....	Odor sour; appearance good; color normal; temperature,—2° C.	.....	.....	.....	.....	.....
		E.	Good	26.65	9.85	3.0	2.7	2.16	.30	.....	.....		.....	.....	.....	.....	.....
		H.	...do	26.47	9.78	2.9	1.8	2.05	.....	0	0	.....	113,000,000	66,000,000	8,500,000	2,200,000	1,000,000
		S.	...do	26.70	9.73	3.1	3.0	1.84	.33	0	0	.....	98,000,000	40,000,000	7,500,000	2,200,000	1,000,000
			Average[3]	26.68	9.79	3.1	2.5	1.93	.30	0	0	.....	105,500,000	53,000,000	8,000,000	2,200,000	1,000,000
72	Sept. 6	B.	Fair	28.87	11.56	2.7	3.1	2.06	.31	.....	.....	Odor strong; appearance good; color normal; temperature, −1° C.	.....	.....	.....	.....	.....
		D.	Bad	.....	.....	.....	.....	.....	.....	0	0		.....	.....	.....	.....	.....

E.	Good	29.05	11.71	2.5	2.7	1.82	.32	......	......	......	......	......	......	......	......
H.	do	28.47	11.50	2.8	[2] 4.5	1.74	.29	......	......	......	30,000,000	6,000,000	900,000	2,600,000	100,000
S.	do	28.59	11.71	2.8	2.7	2.01	.33	......	......	......	36,000,000	6,000,000	850,000	2,000,000	100,000
	Average [3]	28.75	11.62	2.7	2.8	1.91	.31	0	0	......	33,000,000	6,000,000	900,000	2,300,000	100,000
Grand average [3]		27.73	10.73	2.7	2.7	1.90	.31	0	0	......	47,500,000	20,900,000	3,300,000	2,300,000	370,000
Maximum [3]		28.75	11.62	3.1	2.8	1.95	31	0	0	......	105,500,000	53,000,000	8,000,000	2,300,000	1,000,000
Minimum [3]		26.68	9.79	2.2	2.2	1.82	.30	0	0	......	4,100,000	3,800,000	900,000	2,200,000	1,000

[1] Partially melted when received.

[2] Cloudy solution interfered with nesslerization.

[3] Abormal figures omitted.

Formula values: Sample 32= −6.38; sample 48= +0.47+; sample 66= +27.91; sample 72= +3.10.

TABLE 18.—*Results of examination of frozen commercial second-grade whole egg containing no sugar or salt (grading observed in some; material considered by manufacturers to be too good for tanners' grade).*

Sample No.	Date prepared.	Initial of investigator.	Eggs in shell.					Eggs in breaking room.								Size of sample.	How churned.	Time consumed in preparing sample.	Odor when put in freezer.	Temperature of freezer.
			Previous history.	Kind of eggs.	Date received.	Date candled.	Temperature of holding room.	Temperature of breaking room.	Number of breakers.	Number of eggs graded.	Distribution.									
											Used in sample.	As first grade.	As soft grade.	As second grade.	As tanner grade.					
							°F.	°F.			P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	Lbs.		Hrs.		°F.
14	1917. Aug. 6	J.	Cracks from Fort Dodge, Iowa.	Cracks [1]	1917. Aug. 2	1917. Aug. 6	35	63	16							25	Small hand churn	3	Strong	+1
22	Aug. 8	R.	Current receipts from Jacksonville, Ill.	Current receipts [2]	Aug. 4	Aug. 8	37	74	4	849	24	71	0	24	5	20	Small power churn	2½	Good	−5
41	Aug. 10	J. R.	Cracks from June case pack and current receipts from Mount Vernon, Ill.	Cracks and current receipts.[3]	Aug. 4 and 6	Aug. 4 and 6	36	62	2	1,258	5	90	2	5	3	9½	In sample can with sterile milk stirrer.	4		−7
51	do	J.	do	do.[4]	do	do	36	62	5							9¾	do	½	Like tanners.	−7
52	Aug. 4 and 9	R.	Unknown	Unknown [5]												25				
53	May 8	H.	do	do.[6]												30				

[1] Graded commercially. Included good, 32 per cent; light green whites, 21 per cent; very weak, 20 per cent; light sour, 13 per cent; mottled yolks, 5 per cent; advanced hatch spots, 4 per cent; mixed rots (mostly mottled), 4 per cent; embryo, 1 per cent.

[2] Graded out from samples 20 and 21. Included advanced hatch spots and small blood rings, 19 per cent; mottled yolks, 17 per cent; light sour, 14 per cent; cloudy white, 14 per cent; partly addled, 14 per cent; weak, 13 per cent; good, 3 per cent; slightly stuck yolks, 3 per cent; duck, 2 per cent; light green whites, 1 per cent.

[3] Graded out from samples 40, 42, 43, and 44. Included very weak, 35 per cent; advanced hatch spots with mottled yolks, 19 per cent; mottled and bloated yolks, 17 per cent; frozen, 17 per cent; olive-colored yolks, 3 per cent; good, 3 per cent; slightly stuck yolks, 2 per cent; blood rings, 2 per cent; sour, 2 per cent.

[4] Graded out from sample 50. Included frozen, very weak, small blood rings, very mottled yolks, slightly sour, slightly stuck yolks.

[5] Prepared before investigators arrived, therefore unbiased commercial grading.

[6] Commercially packed in May. Purchased in August.

Sample No.	Date analyzed.	Initial of analyst.	Odor when anayzed.	Total solids (wet basis).	Ether extract (wet basis).	Ammonia nitrogen (wet basis).		Acidity of fat as sodium ethylate.	Reducing sugar as dextrose (wet basis).	Indol.	Skatol.	Physical examination.	Organisms per gram.				
						Titration.	Nesslerization.						Plain agar, 20° C., 120 hours.	Plain agar, 37° C., 48 hours.	Acid producers, 37° C., 48 hours.	Alkali producers, 37° C., 48 hours.	Confirmed *B. coli.*
				Per ct.	*Per ct.*	*Mg. per 100 grams.*	*Mg. per 100 grams.*	*Cc. per gram.*	*Per ct.*								
14	1917. Aug. 25	B.	Sour	27.32	10.75	4.0	4.8	1.64	0.25			Odor sour; appearance good; color normal; temp. −2° C.	205,000,000	51,000,000			1,000,000
		D.	do	27.66	11.22	4.2	5.1		.26								
		E.	do							0	0						
		H.	do	28.21	11.12	3.7	2.4	1.88	.26								
		S.	do	27.45	11.09		3.5	1.87	.24				217,000,000	65,000,000			1,000,000
			Average	27.66	11.05	4.0	4.0	1.80	.25	0	0		211,000,000	58,000,000			1,000,000
22	Aug 28	B.	Good	27.86	11.27	3.2	2.9	2.29	.29	0	0	Few blood clots; odor strong; appearance good; color normal; temp. 0° C.	1,400,000	7,100,000	2,400,000	96,000	100,000
		D.	Sour	27.89	11.21	3.0	3.1	2.34	.28	0	0						
		E.	Strong	27.71	10.82	2.7	2.6	1.68	.29								
		H.	Good	27.68	11.10		2.3	1.71					2,200,000	8,300,000	2,800,000	103,000	100,000
			Average	27.79	11.10	3.0	2.7	2.01	.29	0	0		1,800,000	7,700,000	2,600,000	100,000	100,000
41	Aug. 30	B.	Strong	26.85	10.06	3.0	3.0		.32	0	0						
		E.	Good	27.10	10.09	2.3	2.6	1.66	.32	0	0						
		H.	do	27.31	10.22	2.5	1.9	1.79				No embryos or molds; few blood clots and blood rings; odor good; appearance good; temp. 0° C.	340,000	600,000	100,000	0	100,000
		S.	do	27.27	10.33	2.5	2.0	1.70	.31				410,000	900,000	100,000	0	100,000
			Average	27.13	10.18	2.6	2.4	1.72	.32	0	0		380,000	800,000	100,000	0	100,000

TABLE 18.—*Results of examination of frozen commercial second-grade whole egg containing no sugar or salt, etc.*—Continued.

Sample No.	Date analyzed.	Initial of analyst.	Odor when analyzed.	Total solids (wet basis).	Ether extract (wet basis).	Ammonia nitrogen (wet basis).		Acidity of fat as sodium ethylate.	Reducing sugar as dextrose (wet basis).	Indol.	Skatol.	Physical examination.	Organisms per gram.				
						Titration.	Nesslerization.						Plain agar, 20° C., 120 hours.	Plain agar, 37° C., 48 hours.	Acid producers, 37° C., 48 hours.	Alkali producers, 37° C., 48 hours.	Confirmed *B. coli.*
				Per ct.	*Per ct.*	*Mg. per 100 grams.*	*Mg. per 100 grams.*	*Cc. per gram.*	*Per ct.*								
51	1917. Aug. 31	B.	Strong....	29.03	11.81	4.5	4.6	1.89	0.28	......	......	Odor bad; appearance good; color normal; temp. +1° C.	180,000,000	6,900,000	3,000,000	320,000	10,000
		D.	Good.....	29.60	13.25	4.6	4.6	2.21	.25	......	......						
		E.	...do.....	....	....	....	....	....	....	0	0	....	....	....	....	....	....
		H.	...do.....	29.63	12.70	4.4	4.7	2.58	.24	......	......	....	177,000,000	3,900,000	2,400,000	280,000	10,000
		S.	...do.....	29.55	12.01	4.2	3.7	2.19	.30	......	......	....	....	....	....	....	....
			Average..	29.45	12.44	4.4	4.4	2.22	.27	0	0	....	178,500,000	5,400,000	2,700,000	300,000	1,0000
52	Sept. 1	B.	Fair......	28.38	11.31	3.6	2.4	1.74	.28	......	......		....	....	....	....	....
		D.	Strong....	28.45	11.38	3.1	3.6	1.74	.27	......	......	Odor strong; appearance good; temp. 0° C.; nothing of significance.	41,000,000	11,100,000	8,400,000	390,000	100,000
		E.	....	27.80	10.76	2.8	2.9	1.96	.27	0	0		....	....	....	....	....
		S.	Good.....	27.94	10.76	3.2	2.7	1.69	.31	0	0		55,000,000	12,900,000	11,600,000	610,000	100,000
			Average..	28.14	11.05	3.2	2.9	1.78	.28	0	0	....	48,000,000	12,000,000	10,000,000	500,000	100,000
53	...do....	B.	Fair......	30.43	12.82	3.1	2.1	1.66	.30	......	......	Odor strong; appearance good; temp. 0° C.	16,900,000	1,700,000	900,000	100,000	1,000
		D.	Good.....	30.08	12.43	2.8	3.1	1.79	......	......	......						
		E.	....	....	12.55	2.8	2.7	1.74	.26	0	0	....	....	....	....	....	....
		S.	Good.....	31.63	13.39	2.8	2.8	1.75	.31	0	0	....	17,800,000	1,500,000	1,300,000	100,000	10,000
			Average..	30.71	12.80	2.9	2.7	1.76	.29	0	0	....	17,400,000	1,600,000	1,100,000	100,000	5,500
Grand average..................				28.38	11.44	3.7	3.2	1.88	.28	0	0	....	76,500,000	14,400,000	3,500,000	200,000	220,000
Maximum........................				29.45	12.44	4.4	4.4	2.22	.32	0	0	....	211,000,000	58,000,000	10,000,000	500,000	1,000,000
Minimum.........................				27.13	10.18	2.6	2.4	1.72	.25	0	0	....	380,000	800,000	100,000	0	5,500

Formula values: Sample 14= +55.49; sample 22= +2.79; sample 41= −3.38; sample 51= +51.45; sample 52= +11.99; sample 53= −2.04.

TABLE 19.—*Results of examination of frozen experimental tanners' grade whole egg, containing no sugar or salt.*

			Eggs in shell.					Eggs in breaking room.												
											Distribution.									
Sample No.	Date prepared.	Initial of investigator.	Previous history.	Kind of eggs.	Date received.	Date candled.	Temperature of holding room.	Temperature of breaking room.	Number of breakers.	Number of eggs graded.	Used in sample.	As first grade.	As soft grade.	As second grade.	As tanner grade.	Size of sample.	How churned.	Time consumed in preparing sample.	Odor when put in freezer.	Temperature of freezer.
							° *F.*	° *F.*			*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*Lbs.*		*Hrs.*		° *F.*
73	1917. Aug. 14	R.	Checks and dirties from Wisconsin.	Checks and dirties[1]	1917. Aug. 13	1917. Aug. 13 and 14	40	62	1	1,265	6	45	37	12	6	6	In sample can with sterile milk stirrer.	4	Bad......	−10

[1] Grading dictated. Graded out from samples 70, 71, and 72. Included mixed rots, 50 per cent; sour, 28 per cent; very cloudy whites, 5 per cent; stuck yolks, 4 per cent; moldy odor, 4 per cent; green yolks, 4 per cent; unclassified, 3 per cent; very dark yolks, 1 per cent; very stale, 1 per cent.

TABLE 19.—*Results of examination of frozen experimental tanners' grade whole egg, containing no sugar or salt*—Continued.

Sample No.	Date analyzed.	Initial of analyst.	Odor when analyzed.	Total solids (wet basis).	Ether extract (wet basis).	Ammonia nitrogen (wet basis).		Acidity of fat as N/20 sodium ethylate.	Reducing sugar as dextrose (wet basis).	Indol.	Skatol.	Physical examination.	Organisms per gram.				
						Titration.	Nesslerization.						Plain agar, 20° C., 120 hours.	Plain agar, 37° C., 48 hours.	Acid producers, 37° C., 48 hours.	Alkali producers, 37° C., 48 hours.	Confirmed *B. coli.*
				Per ct.	*Per ct.*	*Mg. per 100 grams.*	*Mg. per 100 grams.*	*Cc. per gram.*	*Per ct.*								
73	1917. Sept. 6	D.	Bad	....	....	....	....	....	....	+	+	Odor bad; appearance good; color normal; temperature −1° C.	....	....	....	....	....
		E.	Good	28.41	11.12	2.7	3.3	1.94	0.22	......	......	....	18,700,000	5,000,000	2,000,000	230,000	100,000
		H.	...do	27.01	10.21	3.2	2.0	1.88	.24	......	......	....	13,800,000	3,000,000	2,000,000	170,000	100,000
		S.	...do	27.34	10.59	3.1	3.0	1.86	.28	......	......	....					
			Average	27.59	10.64	3.0	2.8	1.89	.25	+	+	....	16,300,000	4,000,000	2,000,000	200,000	100,000

Formula value: Sample 73= +11.28.

TABLE 20.—*Results of examination of frozen commercial tanners' grade whole egg containing no sugar or salt.*

Sample No.	Date prepared.	Initial of investigator.	Eggs in shell.					Eggs in breaking room.								Size of sample.	How churned.	Time consumed in preparing sample.	Odor when put in freezer.	Temperature of freezer.
			Previous history.	Kind of eggs.	Date received.	Date candled.	Temperature of holding room.	Temperature of breaking room.	Number of breakers.	Number of eggs graded.	Distribution.									
											Used in sample.	As first grade.	As soft grade.	As second grade.	As tanner grade.					
	1917.				1917.	1917.	*° F.*	*° F.*							*P. ct.*	*Lbs.*		*Hrs.*		*° F.*
16	Aug. 7	H.	Current receipts from Oklahoma.	Current receipts.[1]	July 27	Aug. 7	35	63	16	43,000	.....	.....	.....	.....	1	27	In sample can with sterile breaking knife.	4	Bad.....	+ 1
77	Aug. 14	H.	Checks and dirties from Wisconsin.	Checks and dirties.[2]	Aug. 13	Aug. 13 and 14	40	62	7	12,600	.....	.....	.....	.....	2	27	.....do.....	3	...do.....	− 1

[1] Commercial grading. Said to be sold to a manufacturer of tanners' yolks.

[2] Commercial grading. As manufacturer did not expect Bureau representatives to take a sample of this product, grading was unbiased. Said to be used up in fertilizer works.

TABLE 20.—*Results of examination of frozen commercial tanners' grade whole egg containing no sugar or salt*—Continued.

Sample No.	Date analyzed.	Initial of analyst.	Odor when analyzed.	Total solids (wet basis).	Ether extract (wet basis).	Ammonia nitrogen (wet basis).		Acidity of fat as N/20 sodium ethylate.	Reducing sugar as dextrose (wet basis).	Indol.	Skatol.	Physical examination.	Organisms per gram.				
						Titration.	Nesslerization.						Plain agar, 20° C., 120 hours.	Plain agar, 37° C., 48 hours.	Acid producers, 37° C., 48 hours.	Alkali producers, 37° C., 48 hours.	Confirmed *B. coli.*
				Per ct.	*Per ct.*	*Mg. per 100 grams.*	*Mg. per 100 grams.*	*Cc. per gram.*	*Per ct.*								
16	1917. Aug. 22	B.	Putrid...	27.66	10.72	6.6	8.6	2.15	0.21	......	......	1 embryo; 1 blood ring; no mold; odor sour and slightly putrid; appearance good; color normal; temperature 0° C.	264,000,000	104,000,000	....	....	10,000,000
		D.	Sour.....	27.13	10.46	6.7	5.7	2.18	.23	......	......						
		E.	...do.....	27.19	10.52	6.2	6.0	2.08	.23	0	+						
		H.	...do.....	27.43	10.44	....	5.9	2.33	.19	0	+						
		S.	Bad.....	27.37	10.52	5.9	5.8	2.17	.18	0	+	....	133,000,000	98,000,000	....	....	10,000,000
			Average.	27.36	10.53	6.4	6.4	2.18	.21	0	+	....	198,500,000	101,000,000	....	....	10,000,000
77	Sept. 5	B.	....	....	....	....	....	....	....	+	0	Blood rings; shells, dirt; odor bad; appearance good; color normal; temperature −2° C.	340,000,000	221,000,000	26,600,000	77,000,000	10,000,000
		D.	Sour.....	27.20	10.85	6.7	[1]9.4	2.29	0.21	......	......						
		E.	...do.....	27.19	10.21	7.5	7.0	....	....	......	......						
		H.	...do.....	26.55	9.95	6.6	8.0	2.25	.20	......	......						
		S.	Putrid...	26.09	9.77	8.1	8.2	2.34	.22	......	......	....	380,000,000	191,000,000	29,400,000	89,000,000	10,000,000
			Average[2].	26.76	10.20	7.2	7.7	2.29	.21	+	0	....	360,000,000	211,000,000	28,000,000	83,000,000	10,000,000
Grand average[2]				27.09	10.38	6.8	6.9	2.24	.21	+	+	....	279,300,000	156,000,000	28,000,000	83,000,000	10,000,000
Maximum[2]				27.36	10.53	7.2	7.7	2.29	.21	+	+	....	360,000,000	211,000,000	28,000,000	83,000,000	10,000,000
Minimum[2]				26.76	10.20	6.4	6.4	2.18	.21	0	0	....	198,500,000	101,000,000	28,000,000	83,000,000	10,000,000

[1] Cloudy solution interfered with nesslerization.

[2] Abnormal figure omitted.

Formula values: Sample 16= + 105.74; sample 77= +148.04.

TABLE 21.—*Results of examination of frozen commercial drip containing no sugar or salt.*

Sample No.	Date prepared.	Initial of investigator.	Eggs in shell.					Eggs in breaking room.								Size of sample.	How churned.	Time consumed in preparing sample.	Odor when put in freezer.	Temperature of freezer.
			Previous history.	Kind of eggs.	Date received.	Date candled.	Temperature of holding room.	Temperature of breaking room.	Number of breakers.	Number of eggs graded.	Distribution.									
											Used in sample.	As first grade.	As soft grade.	As second grade.	As tanner grade.					
							°*F.*	°*F.*			*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*Lbs.*		*Hrs.*		°*F.*
15	1917. Aug. 7	H.	Current receipts from Oklahoma.	Current receipts [1].	1917. July 27	1917. Aug. 7	35	63	16	......	......	......	......	......	......	24	In sample can with sterile breaking knife.	4	Strong...	+1

Sample No.	Date analyzed.	Initial of analyst.	Odor when analyzed.	Total solids (wet basis).	Ether extract (wet basis).	Ammonia nitrogen (wet basis).		Acidity of fat as N/20 sodium ethylate.	Reducing sugar as dextrose (wet basis).	Indol.	Skatol.	Physical examination.	Organisms per gram.				
						Titration.	Nesslerization.						Plain agar, 20° C., 120 hours.	Plain agar, 37° C., 48 hours.	Acid producers, 37° C., 48 hours.	Alkali producers, 37° C., 48 hours.	Confirmed *B. coli.*
				Per ct.	*Per ct.*	*Mg. per 100 grams.*	*Mg. per 100 grams.*	*Cc. per gram.*	*Per ct.*								
15	1917. Aug 23	E.	Sour.....	19.53	5.37	2.4	3.3	1.84	0.32	0	0	Blood rings; no molds; no embryos; odor strong; appearance good; color light; temperature −2° C.	65,000,000	21,800,000	....	....	1,000,000
		H.	Strong...	20.19	5.59	2.6	2.9	1.90	.37	0	0						
		S.	Good....	21.59	5.90	2.8	3.2	1.94	.36	0	0	....	62,000,000	19,200,000	....	....	1,000,000
			Average.	20.44	5.62	2.6	3.1	1.89	.35	0	0	....	63,500,000	20,500,000	....	....	1,000,000

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[1] Included all drip collected from breaking knives and trays. Proportion of white was high.

Formula value: Sample 15= +23.25.

TABLE 22.—*Results of examination of frozen whole egg prepared from inedible eggs under experimental conditions (containing no sugar or salt).*

			Eggs in shell.					Eggs in breaking room.												
											Distribution.									
Sample No.	Date prepared.	Initial of investigator.	Previous history.	Kind of eggs.	Date received.	Date candled.	Temperature of holding room.	Temperature of breaking room.	Number of breakers.	Number of eggs graded.	Used in sample.	As first grade.	As soft grade.	As second grade.	As tanner grade.	Size of sample.	How churned.	Time consumed in preparing sample.	Odor when put in freezer.	Temperature of freezer.
	1917.				1917.	1917.	°F.	°F.			P.ct.	P.ct.	P.ct.	P.ct.	P.ct.	Lbs.		Hrs.		°F.
23	Aug. 8	J.	Current receipts from Jacksonville, Ill.	Partially addled (mixed rots).[1]	Aug. 4	Aug. 8	37	74	1							26	In sample can with sterile breaking knife.	2	Good	−5
24	...do	J.	...do	Slightly stuck yolks.[2]	...do	...do	37	74	1							10	...do	1½	...do	−5
25	...do	J.	...do	Slightly disintegrated yolks (border-line rots).[3]	...do	...do	37	74	1							20	...do	2	...do	−5
27	Aug. 8 and 9	J.	...do	Completely addled (white rots).[4]	...do	Aug 8 and 9	37	74	1							15	...do	1½	Offensive	−5
28	Aug. 9	J.	...do	Heavily stuck yolks (may be moldy).[5]	...do	...do	37	74	1							26	...do	2	Moldy	−5
68	Aug. 13 and 14	H.	Checks and dirties from Iowa.	Sour[6]	Aug. 11	Aug. 13	40	66	10							6½	In sample can with sterile milk stirrer.	9	Sour	−10
69	...do	H.	...do	Green white[7]	...do	...do	40	66	10							5¼	...do	9	Slightly sour.	−10
75	Aug. 14	J.	Cracks from Davenport, Iowa.	Cracks with moldy shells.[8]	Aug. 10	...do	40	62	1							30	...do	1	Slightly moldy.	−10

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[1] Obtained from candling room rejects. Cups changed after inferior eggs. Consisted of deteriorated broken yolks partially mingled with whites and containing whitish areas.
[2] From candling room rejects. Cups changed after inferior eggs. Had clear whites and yolks attached by small area. Fairly good appearance.
[3] From candling room rejects. Cups changed after inferior eggs. Consisted of spreading yolks, cloudy whites, and mottled yolks.
[4] From candling room rejects. No putrid eggs used. Whites and yolks mingled. Many whitish streaks. Appearance very repulsive.
[5] From candling room rejects. Most showed dark areas before candle. No moldy addled eggs included.
[6] Graded out from regular straight break. Two pounds collected on Aug. 13 in 5 hours and frozen; 4½ pounds added on Aug. 14 in 4 hours. Churned and frozen.
[7] Graded out from regular straight break. One and three-quarter pounds collected on Aug. 13 in 5 hours and frozen; 3¾ pounds added on Aug. 14 in 4 hours. Churned and frozen.
[8] No stuck yolks, green whites, or sours included.

Sample No.	Date analyzed.	Initial of analyst.	Odor when analyzed.	Total solids (wet basis).	Ether extract (wet basis).	Ammonia nitrogen (wet basis).		Acidity of fat as N/20 sodium ethylate.	Reducing sugar as dextrose (wet basis).	Indol.	Skatol.	Physical examination.	Organisms per gram.				
						Titration.	Nesslerization.						Plain agar, 20° C., 120 hours.	Plain agar, 37° C., 48 hours.	Acid producers, 37° C., 48 hours.	Alkali producers, 37° C., 48 hours.	Confirmed *B. coli.*
				Per ct.	*Per ct.*	*Mg. per 100 grams.*	*Mg. per 100 grams.*	*Cc. per gram.*	*Per ct.*								
23	1917. Aug. 27	B.	Fair	28.65	11.42	4.5	4.2	1.99	0.25	0	0	Odor strong; melted.[1]	...	...	...	...	...
		D.	Strong	28.63	11.41	...	4.9	2.32	.24	0	0	...	...	...	...	...	...
		E.	Fair	28.01	11.34	4.1	3.6	2.28	.24	...	...	...	...	...	...	...	...
		H.	Good	28.04	11.49	4.9	4.7	1.81	.25	...	...	...	...	...	...	...	...
		S.	...do	28.60	11.32	4.4	3.8	2.37	.23	...	...	...	...	...	...	...	...
			Average	28.39	11.40	4.5	4.2	2.15	.24	0	0	...	...	...	...	...	...
24	...do	B.	Eggy	27.89	10.80	2.9	2.8	1.88	.30	0	0	Odor very strong; melted.[2]	...	...	...	...	...
		D.	Strong	28.14	10.92	2.7	4.0	2.22	...	0	0	...	...	...	...	...	...
		E.	Fair	27.90	10.89	...	2.5	2.19	.29	...	...	...	...	...	...	...	...
		H.	Good	27.84	11.01	2.6	2.6	1.93	.27	...	...	...	...	...	...	...	...
		S.	...do	27.55	10.55	2.9	2.9	2.11	.28	...	...	...	...	...	...	...	...
			Average	27.86	10.83	2.8	3.0	2.07	.29	0	0						
25	...do	B.	Fair	28.27	10.97	3.3	3.1	1.93	...	...	...	Odor sour; melted.[1]	...	...	...	...	...
		D.	Strong	27.63	...	3.3	3.4	...	.26	...	...	...	...	...	...	...	...
		E.	Fair	28.14	11.29	3.1	2.7	2.31	.31	0	0	...	...	...	...	...	...
		H.	Good	27.83	11.32	2.6	2.7	1.82	.28	0	0	...	...	...	...	...	...
		S.	...do	26.69	10.44	3.4	2.9	1.99	.31	...	...	...	...	...	...	...	...
			Average	27.71	11.01	3.1	3.0	2.01	.29	0	0	...	...	...	...	...	...
27	...do	B.	Moldy	27.98	11.28	13.2	11.2	3.26	.09	...	...	Odor sour; melted.[2]	...	...	...	...	...
		D.	Sour	28.37	11.36	12.6	13.3	3.68	.13	...	...	...	...	...	...	...	...
		E.	Sour and putrid.	28.19	11.41	12.8	11.6	3.63	.13	0	+	...	...	...	...	...	...
		H.	Bad	28.07	11.63	13.0	9.8	3.15	.13	0	+	...	...	...	...	...	...
		S.	Moldy	29.11	11.22	12.6	13.3	3.59	.11	...	...	Blood ring; blood clots; shells.	...	...	...	...	...
			Average	28.34	11.38	12.8	11.8	3.46	.12	0	+	...	...	...	...	...	...

[1] Partially melted when received.

[2] Completely melted when received.

TABLE 22.—*Results of examination of frozen whole egg prepared from inedible eggs under experimental conditions (containing no sugar or salt)*—Con.

Sample No.	Date analyzed.	Initial of analyst.	Odor when analyzed.	Total solids (wet basis).	Ether extract (wet basis).	Ammonia nitrogen (wet basis).		Acidity of fat as N/20 sodium ethylate.	Reducing sugar as dextrose (wet basis).	Indol.	Skatol.	Physical examination.	Organisms per gram.				
						Titration.	Nesslerization.						Plain agar, 20° C., 120 hours.	Plain agar, 37° C., 48 hours.	Acid producers, 37° C., 48 hours.	Alkali producers, 37° C., 48 hours.	Confirmed *B. coli*.
				Per ct.	*Per ct.*	*Mg. per 100 grams.*	*Mg. per 100 grams.*	*Cc. per gram.*	*Per ct.*								
28	1917. Aug. 27.	B.	Sour	27.98	10.93	13.1	10.9	6.76	0.04	......	......	Odor sour and slightly putrid; melted.[1]	......	......	......	......	......
		D.	Sour and moldy.	28.05	11.05	12.7	12.2	7.98	.08	......	......	......	......	......	......	......	......
		E.	Very sour	27.88	11.15	12.8	10.0	6.60	.05	......	......	......	......	......	......	......	......
		H.	Bad	28.25	11.43	12.3	7.8	5.56	.04	......	......	......	......	......	......	......	......
		S.	Sour	27.75	11.06	13.3	11.4	6.17	.04	+	0	......	......	......	......	......	......
			Average	28.38	11.12	12.8	10.5	6.61	.05	+	0	......	......	......	......	......	......
68	Sept. 6	B.	Sour	27.50	10.59	......	5.8	2.21	.18	0	0	Odor sour; appearance good; color normal; temp. –1° C.	......	......	......	......	......
		E	...do	27.78	10.62	4.2	6.5	2.07	.19	0	0						
		H.	Bad	28.44	10.80	4.9	3.7	......	.16	0	0	......	399,000,000	378,000,000	24,700,000	138,000,000	10,000,000
		S.	Putrid	27.45	10.55	4.5	5.5	2.28	.22	......	......	......	395,000,000	362,000,000	23,300,000	132,000,000	10,000,000
			Average	27.79	10.64	4.5	5.4	2.19	.19	0	0	......	397,000,000	370,000,000	24,000,000	135,000,000	10,000,000
69	...do	B.	Strong	27.15	9.83	5.4	5.8	......	.18	0	0	Odor sour; appearance good; color normal; temp. –1° C.	......	......	......	......	......
		E.	Good	27.62	10.07	4.4	6.5	1.82	.16	0	0						
		H.	...do	26.99	10.15	5.0	4.5	1.94	.18	......	......	......	249,000,000	197,000,000	33,000,000	38,000,000	10,000,000
		S.	Strong	27.21	10.01	4.7	5.7	1.85	.20	......	......	......	321,000,000	230,000,000	37,000,000	42,000,000	10,000,000
			Average	27.24	10.02	4.9	5.6	1.87	.18	0	0	......	285,000,000	213,500,000	35,000,000	40,000,000	10,000,000
75	Sept. 4	B.	Good	27.53	10.69	2.2	1.8	......	......	......	......	No mold; 1 green spot with filaments; odor moldy; appearance good; color normal; temp. –2 °C.	......	......	......	......	......
		D.	Moldy	27.50	10.58	2.8	2.1	1.83	.24	......	......		4,300,000	900,000	90,000	0	10,000

		E.	Good.....	27.53	10.58	2.3	2.1	1.88	.30	......	......	....	....	....	....	....	....
		H.	...do......	26.15	10.74	2.2	2.3	1.91	.28	......	......	....	....	....	....	....	....
		S.	....	....	....	....	....	....	....	+	0	....	4,600,000	900,000	110,000	0	10,000
			Average..	27.18	10.65	2.4	2.1	1.87	.27	+	0	....	4,500,000	900,000	100,000	0	10,000

[1] Partially melted when received.

Formula values: Sample 23= +19.02+; sample 24= +1.14+; sample 25= +3.41+; sample 27= +123.18+; sample 28= +156.77+; sample 68= +121.57; sample 69= +101.49; sample 75= +2.32.

TABLE 23.—*Results of examination of frozen experimental whole egg containing no sugar or salt, to show progressive decomposition.*

Sample No.	Date prepared.	Initial of investigator.	Eggs in shell.					Eggs in breaking room.								Size of sample.	How churned.	Time consumed in preparing sample.	Odor when put in freezer.	Temperature of freezer.
			Previous history.	Kind of eggs.	Date received.	Date candled.	Temperature of holding room.	Temperature of breaking room.	Number of breakers.	Number of eggs graded.	Distribution.									
											Used in sample.	As first grade.	As soft grade.	As second grade.	As tanner grade.					
	1917.				1917.	1917.	°*F.*	°*F.*								*Lbs.*		*Hrs.*		°*F.*
60	Aug. 13	H.	Checks and dirties from Iowa.	Checks and dirties[1]	Aug. 8, 11	Aug. 11, 13	40	66	10	......	......	......	......	......	......	15	In large power churn.	1	Good.....	−10
61	...do.....	H.	.....do..................	.....do.[2]...........	...do.....	...do.....	40	66	10	......	......	......	......	......	......	15	.....do............	1	Strong...	−10
62	...do.....	H.	.....do..................	.....do.[3]...........	...do.....	...do.....	40	66	10	......	......	......	......	......	......	15	.....do............	1	Slightly sour.	−10
63	...do.....	H.	.....do..................	.....do.[4]...........	...do.....	...do.....	40	66	10	......	......	......	......	......	......	15	.....do............	1	Sour and putrid.	−10

[1] Commercially graded; sample placed in freezer immediately.
[2] From same churnful as sample 60; sample held at 66° for 6 hours before placing in freezer.
[3] From same churnful as sample 60; sample held at 66° for 23 hours before placing in freezer.
[4] From same churnful as sample 60; sample held at 66° for 29½ hours before placing in freezer.

TABLE 23.—*Results of examination of frozen experimental whole egg containing no sugar or salt, to show progressive decomposition*—Continued.

Sample No.	Date analyzed.	Initial of analyst.	Odor when analyzed.	Total solids (wet basis).	Ether extract (wet basis).	Ammonia nitrogen (wet basis).		Acidity of fat as N/20 sodium ethylate.	Reducing sugar as dextrose (wet basis).	Indol.	Skatol.	Physical examination.	Organisms per gram.				
						Titration.	Nesslerization.						Plain agar, 20° C., 120 hours.	Plain agar, 37° C., 48 hours.	Acid producers, 37° C., 48 hours.	Alkali producers, 37° C., 48 hours.	Confirmed *B. coli.*
				Per ct.	*Per ct.*	*Mg. per 100 grams.*	*Mg. per 100 grams.*	*Cc. per gram.*	*Per ct.*								
60	1917. Sept. 4	B.	Good....	28.95	11.78	2.5	2.3	1.82	0.32	0	0	Odor good; appearance good; color normal; temp., −2° C.	......	......	......	......	......
		D.	...do.....	29.30	11.92	3.0	3.1	1.78	......	0	0						
		E.	...do.....	28.84	11.96	2.6	2.3	1.89	.31	......	......	......	3,000,000	1,500,000	600,000	50,000	100,000
		H.	...do.....	28.56	11.46	3.0	2.6	......	.29	......	......	......	2,600,000	1,800,000	600,000	50,000	10,000
			Average.	28.91	11.78	2.8	2.6	1.83	.31	0	0	......	2,800,000	1,700,000	600,000	50,000	55,000
61	...do.....	B.	Fair.....	28.74	11.65	2.7	3.2	1.75	.32	0	0	Odor strong; appearance good; color normal; temp., −2° C.	4,400,000	3,000,000	900,000	78,000	10,000
		D.	Strong...	29.34	11.88	2.8	2.9	1.72	......	0	0						
		E.	Good....	29.11	11.96	2.6	2.4	2.09	.29	......	......	......	4,100,000	2,500,000	650,000	82,000	10,000
		H.	...do.....	28.87	11.77	3.0	3.0	2.07	.29	......	......	......					
			Average.	29.02	11.82	2.8	2.9	1.91	.30	0	0	......	4,300,000	2,800,000	800,000	80,000	10,000
62	...do.....	B.	Sour.....	28.38	11.60	6.5	[1]3.5	2.25	.04	......	......	Odor sour; appearance good; color normal; temp., −2° C.	287,000,000	296,000,000	287,000,000	12,700,000	10,000,000
		D.	...do.....	28.91	11.81	6.9	6.3	2.18	.00	......	......						
		E.	...do.....	28.28	11.53	6.5	6.1	2.36	.04	0	0	......	282,000,000	291,000,000	273,000,000	11,300,000	10,000,000
		H.	Bad.....	28.79	11.85	6.8	6.5	2.36	.01	0	0	......					
			Average[2]	28.59	11.70	6.7	6.3	2.29	.02	0	0	......	284,500,000	293,500,000	280,000,000	12,000,000	10,000,000
63	...do.....	B.	Sour.....	27.99	11.28	8.3	[1]5.9	2.20	.00	0	0	Odor bad; appearance good; color normal; temp., −2° C.	282,000,000	246,000,000	144,000,000	11,700,000	1,000,000
		D.	...do.....	28.81	11.70	7.6	9.9	2.21	.00	......	......						
		E.	...do.....	27.81	11.23	8.0	7.0	2.34	.00	0	0	......	218,000,000	230,000,000	137,000,000	10,400,000	1,000,000
		H.	Bad.....	27.96	11.31	8.7	7.8	2.33	.00	0	0	......					
			Average[2]	28.14	11.38	8.2	8.2	2.27	.00	0	0	......	250,000,000	238,000,000	140,500,000	11,100,000	1,000,000

[1] Lost by spattering.

[2] Abnormal figure omitted.

Formula values: Sample 60= −3.17; sample 61= −2.05; sample 62= +126.05; sample 63= +115.43.

DISCUSSION OF RESULTS OF EXAMINATION.

The following conclusions may be drawn from Tables 8 to 23.

1. Using the methods of examination as modified during this investigation and fully described on pages 85 to 96, several analysts when examining the same samples at the same time obtained results which agree closely. This is important, as it proves that the methods are reliable and with justice to producer and consumer alike may be depended upon as the basis for judgment concerning the degree of decomposition which has taken place.

2. The differences shown by the analytical results parallel to a remarkable degree the results of physical examination as determined in advance by examination of the individual eggs comprising the samples. It is therefore evident that from an analysis of a frozen egg product an accurate decision may be reached concerning the character of the raw materials used in its preparation.

3. In the samples of experimental first-grade whole egg (Table 8) the very close agreement in the results obtained from different samples for ammonia nitrogen, acidity of fat, and reducing sugar should be noted in connection with the fact that the raw materials used came from three different States. In the seven samples of this product the average ammonia nitrogen figures were respectively 1.9, 2.1, 2.2, 2.1, 2.4, 2.2, and 2.3 milligrams per 100 grams; the average acidity of fat figures were 1.84, 1.87, 1.92, 1.89, 1.85, 1.86, and 1.86 cubic centimeters of N/20 sodium ethylate required per gram; and the average reducing sugar figures were 0.30, 0.30, 0.29, 0.31, 0.30, 0.27, and 0.29 per cent. The comparatively low figures found for ammonia nitrogen and for acidity of fat, and the high figures for reducing sugar in the case of these eggs packed in August, when eggs are admittedly of the poorest quality, are also worthy of note, and prove conclusively that eggs showing practically no decomposition occur in ordinary breaking stock, even in August. The proper inference is that the degree to which such eggs are present is proportional to the care with which the eggs while still in the shell have been gathered, cooled, and handled. An index to the amount of care in handling used in August, 1917, is furnished by the fact that in sample 64 only 57 per cent of the eggs graded could be placed in first-grade frozen whole egg, and in sample 70 only 45 per cent could be so used. The fact that in these two samples it was necessary to place 26 and 37 per cent, respectively, in the soft grade indicates clearly that the raw material became too greatly heated during transportation or storage. This is further emphasized from another point of view by the fact that sample 46, prepared principally from cracks from June case packs which had been held subsequently in cold storage for two months, showed ammonia nitrogen to the extent of 2.1 milligrams per 100 grams, acidity of fat of 1.89

cubic centimeters of N/20 sodium ethylate required per gram, and reducing sugar of 0.31 per cent.

4. The figures obtained from the products prepared experimentally by the investigators cited showed somewhat less decomposition than the figures obtained from products prepared commercially from the the same raw materials (Table 9). In the six samples of the latter product, the average ammonia nitrogen figures were, respectively, 2.3, 2.5, 2.3, 2.8, 2.5, and 2.6 milligrams per 100 grams; the average acidity of fat figures were 1.95, 1.83, 1.77, 1.77, 1.73, and 1.76 cubic centimeters of N/20 sodium ethylate required per gram; and the average reducing sugar figures were 0.31, 0.30, 0.32, 0.29, 0.30, and 0.32 per cent. This is readily explained by the fact that in the three samples in which a record of distribution was kept, it was found that 92, 89, and 94 per cent of the eggs graded were placed in the first-grade products by the commercial graders, as compared with 57 and 45 per cent as graded by the investigators.

5. The bacterial contents of the first-grade experimentally prepared and first-grade commercially prepared samples were very similar, as was the distribution of the bacteria into groups in both types of sample. In the experimentally prepared samples the total bacterial counts averaged 4,000,000 per gram, with a maximum of 10,500,000 and a minimum of 120,000, while in the commercially prepared samples the corresponding figures were 2,600,000, 5,300,000, and 160,000.

6. In close agreement with the figures already cited are those obtained from commercially prepared first-grade whole egg containing sugar and salt (Table 10). In the five samples of this product, one of which was prepared in April and the other four in August, the average ammonia nitrogen figures were 1.8, 2.4, 2.5, 2.3, and 2.4 milligrams per 100 grams; the average acidity of fat figures were 1.68, 1.69, 1.90, 1.80, and 1.67 cubic centimeters of N/20 sodium ethylate required per gram; and the average reducing sugar figures were 0.30, 0.28, 0.31, 0.29, and 0.30 per cent. In these samples the total bacterial counts averaged 340,000, 15,000,000, 7,800,000, 2,900,000, and 6,300,000 per gram.

7. Although an attempt was made to separate edible breaking stock eggs into two portions, one (first grade) to be of higher quality than the other (soft grade), a comparison of the results already cited for first-grade whole egg with those obtained from experimentally prepared soft-grade (Table 11) and commercially prepared soft-grade (Table 12) whole egg indicates very strongly that such grading is impracticable with breaking stock eggs. In the four samples of experimentally prepared soft-grade whole egg, the average ammonia nitrogen figures were 2.3, 2.2, 2.5, and 2.4 milligrams per 100 grams; the average acidity of fat figures were 1.82, 1.84, 1.84, and 1.82 cubic

centimeters of N/20 sodium ethylate required per gram; the average reducing sugar figures were 0.29, 0.28, 0.32, and 0.30 per cent; and the average total bacterial count was 3,600,000 per gram, with a maximum of 9,300,000 and a minimum of 320,000. In the three samples of commercially prepared soft-grade whole egg, two of which were prepared in August and one in April, the average ammonia nitrogen figures were 2.4, 2.4, and 2.0, milligrams per 100 grams; the average acidity of fat figures were 1.84, 1.99, and 1.73 cubic centimeters of N/20 sodium ethylate required per gram; the average reducing sugar figures were 0.27, 0.33, and 0.32 per cent; and the average total bacterial count was 1,600,000 per gram, with a maximum of 3,800,000 and a minimum of 130,000.

8. As it is the practice in some breaking plants to have the "leakers" broken out by the candlers in the semidarkness of the candling room where proper grading is impossible, the products referred to in Table 13 were prepared under varying conditions. The results are clearly in favor of the leakers opened in the breaking room.

9. The results in Table 14 were obtained from experimentally prepared first-grade yolk of the same general quality as the samples of whole egg reported in Table 8. In the two samples prepared and examined, the average ammonia nitrogen figures were 4.1 and 4.4 milligrams per 100 grams; the average acidity of fat figures were 1.81 and 1.80 cubic centimeters of N/20 sodium ethylate required per gram; the average reducing sugar figures were 0.20 and 0.18 per cent; and the average total bacterial counts were 240,000 and 280,000 per gram.

10. Indistinguishable from the samples just discussed, even though showing somewhat higher bacterial counts, were the samples of commercially prepared first-grade yolk (Table 15). In the four samples of the latter product the average ammonia nitrogen contents were 4.2, 4.2, 4.0, and 4.2 milligrams per 100 grams; the average acidity of fat figures were 1.97, 1.85, 1.99, and 1.84 cubic centimeters of N/20 sodium ethylate required per gram; the average reducing sugar results were 0.20, 0.19, 0.17, and 0.17 per cent; and the average total bacterial counts were 5,300,000, 270,000, 3,000,000, and 1,600,000 per gram. Because only eggs with fairly firm yolks can be separated commercially, the proportion of the eggs graded commercially into the first-grade yolk in the two samples in which a distribution record was kept was decidedly lower than in the case of commercially prepared whole egg. This explains why the experimental yolk and commercial yolk gave analytical results which agreed much more closely than in the case of the experimentally and commercially prepared whole egg. In the two samples mentioned, 77.0 per cent and 71.0 per cent of the eggs graded were placed in the samples.

11. The commercially prepared first-grade yolk containing sugar (Table 16) yielded results in close agreement with the unsugared yolk of similar grade.

12. Up to this point the tables have dealt with samples which were considered fit for food by the representatives of the Bureau. From now on they deal with samples considered inedible or of questionable quality. Not all of the eggs which entered the samples described in Tables 17 and 18 were inedible. In fact, many edible eggs were used in these products, but the proportion of inedible eggs used was large enough to warrant considering the resulting mixtures inedible.

13. In the samples of experimental second-grade egg reported in Table 17, the comparatively high ammonia nitrogen figures of 2.9, 3.1, and 2.7 milligrams per 100 grams in samples 48, 66, and 72, and the very high bacterial counts of 105,500,000 and 33,000,000 per gram in samples 66 and 72 should be noted. It is unfortunate that no bacterial counts could be made in the case of sample 48, for the reason that it was partially melted during transportation from a freezer to the laboratory. The amount of melting was not sufficient, however, to affect the chemical results.

14. In the samples of commercial second-grade egg shown in Table 18, the average figures of 4, 3, 2.6, 4.4, 3.2, and 2.9 milligrams per 100 grams for ammonia nitrogen; of 1.80, 2.01, 1.72, 2.22, 1.78, and 1.76 cubic centimeters of N/20 sodium ethylate required per gram for acidity of fat; of 0.25, 0.29, 0.32, 0.27, 0.28, and 0.29 per cent for reducing sugar; and of 211,000,000, 1,800,000, 380,000, 178,500,000, 48,000,000, and 17,400,000 bacteria per gram indicate clearly the generally unsatisfactory character of the product.

15. Table 19 shows the results of the examination of a sample of experimentally prepared tanners' grade egg which is undoubtedly inedible. In it the average ammonia nitrogen figure was 3 milligrams per 100 grams; the average acidity of fat was 1.89 cubic centimeters of N/20 sodium ethylate required per gram; the average reducing sugar result was 0.25 per cent; indol and skatol, which are indicators of marked decomposition, were present; and the average bacterial count was 16,300,000 per gram. It should be noted that this sample contained 6 per cent of the eggs graded.

16. In strong contrast with the figure of 6 per cent in the experimental tanners' egg are the figures of 1 per cent and 2 per cent of eggs graded out as tanners' egg by the manufacturers (Table 20). The lower proportion of eggs so graded by the manufacturers is clearly reflected in the analytical results of 6.4 and 7.2 milligrams per 100 grams for ammonia nitrogen, of 2.18 and 2.29 cubic centimeters of N/20 sodium ethylate required per gram for acidity of fat, of 0.21 and 0.21 per cent for reducing sugar, of 198,500,000 and 360,000,000 per gram for bacterial counts, and by the presence of indol and skatol.

17. The question of the propriety of saving and freezing the drip from the breaking knives and trays has arisen several times. Giving due consideration to the effect upon the analytical figures of the large proportion of egg white contained in drip, the results of analysis of such material (Table 21) show that it was decomposed to such an extent and had such a high bacterial count that it was unquestionably unfit for food. The average figures were: For total solids, 20.44 per cent; for ether extract, 5.62 per cent; for ammonia nitrogen, 2.6 milligrams per 100 grams; for acidity of fat, 1.89 cubic centimeters of N/20 sodium ethylate required per gram; for reducing sugar, 0.35 per cent; and for bacterial count, 63,500,000 per gram. The odor was strong and sour.

18. The results so far discussed were obtained on samples which contained more than one kind of egg, for the reason that they were made as commercial frozen egg products would normally be made. The proportions of the different types of egg which went into each sample are shown in Tables 8 to 21. Table 22, however, includes a group of samples, each prepared from only one kind of egg, all of which were considered inedible. The table is self-explanatory. Unfortunately, bacteriological examination could not be made of samples 23, 24, 25, 27, and 28 because their delivery from a freezer was so delayed that they became too much melted for the purpose. They were not sufficiently melted, however, to affect the chemical results.

19. In some small breaking plants not provided with "sharp" freezers, with which all breaking plants should be equipped, it is the practice to save the liquid egg all day, transporting it to a freezer at the close of work. Eggs are too perishable a product to be treated in this way, as shown by the fact that when portions of sample 60, which showed 2.8 milligrams per 100 grams for ammonia nitrogen, 1.83 cubic centimeters of N/20 sodium ethylate required per gram for acidity of fat, 0.31 per cent for reducing sugar, and 2,800,000 bacteria per gram, were held for 23 and 29 hours at 66° F. they showed, respectively, 6.7 and 8.2 milligrams per 100 grams for ammonia nitrogen, 2.29 and 2.27 cubic centimeters of N/20 sodium ethylate required per gram for acidity of fat, 0.02 and 0.00 per cent for reducing sugar, and 284,500,000 and 250,000,000 bacteria per gram (Table 23).

20. Tables 8 to 23 clearly indicate that the standard analytical methods evolved during this investigation gave concordant results in the hands of a number of analysts, and that the results thus obtained correspond to the quality of the egg product. It becomes possible, therefore, to express in some concrete form a composite picture of each sample examined.

INTERPRETATION OF RESULTS OF INVESTIGATION.

A series of plots (figs. 1, 2, 3, 4, and 5) was made, with the purpose of finally grouping into a single expression the information obtained.

AMMONIA NITROGEN.

On cross-section paper the amounts of ammonia nitrogen, expressed as milligrams per 100 grams of sample on the wet basis, were plotted as ordinates against the percentages of ether extract as abscissas. The percentages of ether extract as abscissas were chosen not because the ether extract is destroyed by bacterial or enzymatic action in direct proportion as the ammonia increases, but because the normal amount of ammonia was found to be greater in yolk than in whole egg, even when prepared from the freshest eggs obtainable. It is also a known fact that practically all of the ammonia nitrogen occurs in the yolk and that there is no appreciable increase of ammonia nitrogen in the whites of storage eggs or in decaying liquid whites. Therefore any increase in ammonia nitrogen in whole egg is due to decomposition of the yolk, of which the white acts practically as a diluent. Because the ether extract is the best available measure of the amount of yolk present, it was used as the abscissa. Moreover, there is a very great tendency at present to make yolky mixtures, which theoretically may be judged as to quality, as far as ammonia is concerned, if a curve can be drawn, one end of which is determined by the results found for white and the other end for yolk, and which will pass at an intermediate point through the results for whole egg.

The increased amounts of yolky mixture now made are largely due to the demand at present for much more yolk than white. If no preventive steps were taken, white would become a drug on the market. Consequently, in making contracts, especially in the producing section, many breakers demand that the bakers shall take equivalent amounts of yolk and white. As this would provide the bakers with more white than they need if they based orders on their requirements for yolk, they overcome the difficulty by ordering what white they need and then arranging that the equivalent amount of yolk shall be mixed with enough whole egg to give them an amount of yolky mixture equal to the necessary amount of yolk. They can not entirely substitute yolky mixture for yolk, but they can do so to a very large extent, if they are careful not to have so much whole egg in the mixture that their baking recipes are upset. Obviously, in filling one contract, the amount of yolk in the yolky mixtures may be high, while in another it may be low, with the possibility of all degrees of intermediate mixtures. The amount of whole egg in the mixture has been observed to increase as the season advances. To judge such mixtures fairly it has been proposed that the ammonia nitrogen be calculated to a water-free, fat-free, sugar-free basis, instead of to the much simpler wet basis. This would be necessary except for the fact that the same result is accomplished with much less labor by plotting the ammonia nitrogen against the ether extract.

Such a plot of the results in Tables 1 to 23 is presented in figure 1. In it the positions for the results from samples considered edible are shown by dots, while crosses have been used for the results from inedible samples. In the case of border-line or questionable samples, each result has been indicated by a dot with a line drawn through it.

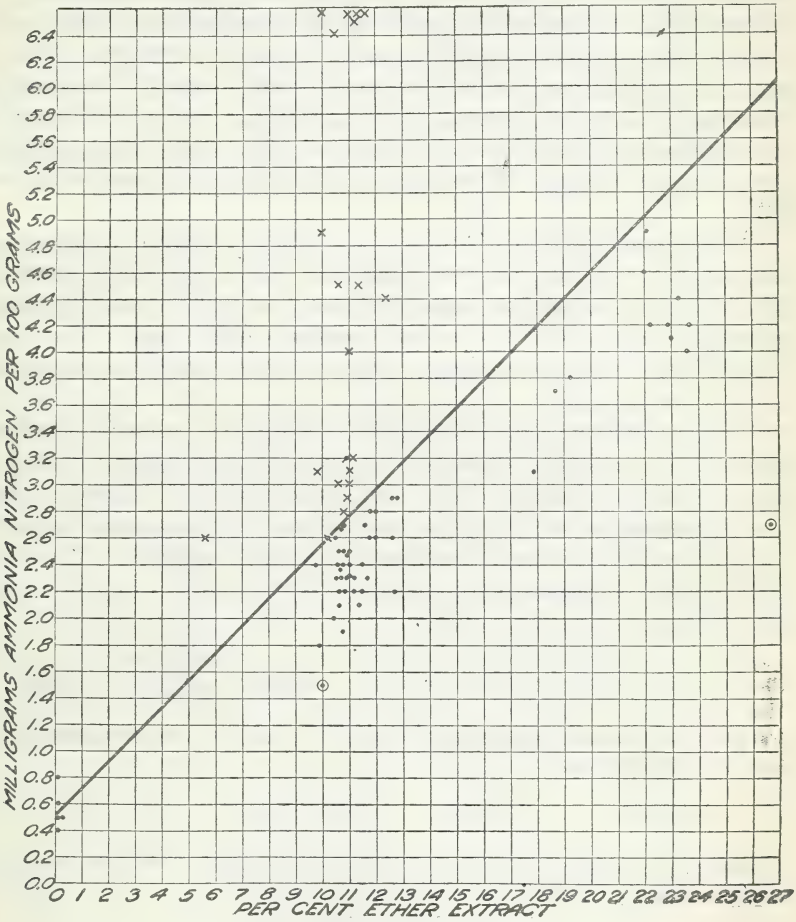

FIG. 1.—Ammonia nitrogen results.

A line, which separates very well the dots from the crosses, has been so located that all of the dots are below it, with the exception of two at the extreme left of the chart which represent white and undoubtedly are due to analytical errors. The dots and crosses between 9.5 and 13 per cent of ether extract represent whole egg. Within these limits the maximum amount of ammonia nitrogen, as indicated by the line, varies from 2.45 to 3.16 milligrams per 100 grams. The dots between 22 and 24 per cent of ether extract indicate yolk, and in these samples the maximum ammonia nitrogen varies from 5 to 5.4 milligrams per 100 grams. The encircled dot at the intersection of 26.65 per cent of ether extract and 2.7 milligrams of ammonia nitrogen represents yolk from the freshest eggs obtainable. The corresponding dot for whole egg is at the intersection of 10 per cent of ether extract and 1.5 milligrams of ammonia nitrogen. The distance below the line at which these dots are located is noteworthy. The dots in the neighborhood of 18 and 19 per cent of ether extract represent sugared yolk, and the cross at the intersection of 5.7 per cent ether extract and 2.6 milligrams of ammonia nitrogen represents drip.

As almost all of these results were obtained from August eggs, when eggs are in the poorest condition, there can be no reason to believe that the ammonia nitrogen figures for edible material will be appreciably above the line at any season of the year. The line is applicable for white, whole egg, yolk, or yolky mixtures made from fresh or storage eggs.

To carry such a plot continually around in order to ascertain whether the result for ammonia nitrogen of any sample would fall above or below the line would be inconvenient. Moreover, some form of expression which can be used in forming a composite picture of all of the different analytical results is very desirable. The proper mathematical expression for the line is evidently what is needed. The expression for such a line is

$$Y-Y'=\frac{Y'-Y''}{X'-X''}(X-X') \quad \text{or} \quad R-R'=\frac{R'-R''}{Q'-Q''}(Q-Q')$$

Widely separated values for R', Q', R'', and Q'' were selected from the plot as follows:

$$R'=0.5 \qquad Q'=0.0 \qquad R''=5.0 \qquad Q''=22.0$$

These values establish the position of the line, whether analytical results or not. Then

$$R-0.5=\frac{0.5-5.0}{0.0-22.0}(Q-0.0)$$

and the vertical distance of any point from this line, in terms of milligrams of ammonia nitrogen per 100 grams of sample, will be

$$D=R-0.5-\left[\frac{0.5-5.0}{0.0-22.0}(Q-0.0)\right]$$

Solving this equation, it becomes

$$D=R-0.205\ Q-0.5$$

If dealing with a sample of unknown quality, substitute for R in the equation the milligrams of ammonia nitrogen per 100 grams of sample on the wet basis, and for Q the percentage of ether extract. If on solving it, the result is less than zero, the sample contains less ammonia nitrogen for the amount of ether extract involved than was found to be the maximum amount in the samples examined in this investigation, and may be considered edible as far as ammonia nitrogen is concerned, although the determinations of other constituents might show it to be inedible. Obviously, the magnitude of the figure measures the quality of the sample, in respect to this one constituent. If on solving, the result is more than zero, the converse interpretation is applicable.

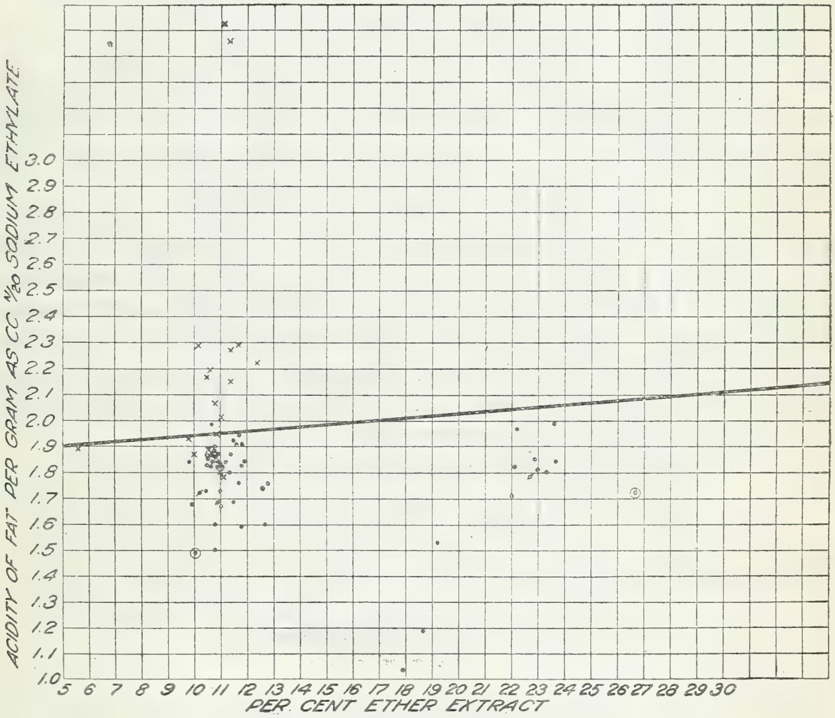

FIG. 2—Acidity of fat results.

ACIDITY OF THE FAT.

As has already been pointed out, the acidity of the fat is normally slightly higher in yolk than in whole egg of the same quality, although theoretically there should be no difference. It is therefore logical, as in the case of ammonia nitrogen, to plot the acidity of the fat against the ether extract, expressing the acidity as the equivalent number of cubic centimeters of N/20 sodium ethylate per gram of fat and the ether extract as per cent. The plot will hold for yolky mixtures, as well as for whole egg or yolk, prepared from either fresh eggs or storage eggs.

Such a plot of the results in Tables 1 to 23 is given in figure 2, the dots and crosses having the same significance as in the ammonia nitrogen plot (fig. 1). A line separating them has been drawn, leaving six crosses below the line, and one dot above it. If there were six dots above the line and one cross below it, the position of the line might with justice be criticised. The fact that there are six crosses below the line, however, merely shows that, in those particular samples, the decomposition was not of a lipolytic nature, but was of a proteolytic or fermentative nature.

The dots and crosses between 9.5 and 13 per cent of ether extract represent whole egg. Within those limits the maximum amount of acidity of the fat, as indicated by the line, varies from 1.94 to 1.97 cubic centimeters of N/20 sodium ethylate required per gram. The dots between 22 and 24 per cent of ether extract, representing yolk, show a corresponding variation for acidity of the fat from 2.04 to 2.06 cubic centimeters of the N/20 sodium ethylate required per gram. The dot at the intersection of 26.65 per cent of ether extract and 1.72 cubic centimeters sodium ethylate required stands for yolk from the freshest eggs obtainable. The corresponding dot for whole egg lies at the intersection of 10 per cent of ether extract and 1.49 cubic centimeters required. The distance below the line at which these dots are located should be noted. The dots in the neighborhood of 18 and 19 per cent of ether extract represent sugared yolk, while the cross at the intersection of 5.7 per cent of ether extract and 1.89 cubic centimeters of N/20 sodium ethylate required represents drip.

Again, widely separated values are selected from the plot:

$$Q' = 5.0 \qquad S' = 1.90 \qquad Q'' = 29.0 \qquad S'' = 2.10$$

These may be substituted in the straight-line expression

$$S - S' = \frac{S' - S''}{Q' - Q''}(Q - Q')$$

to give

$$S - 1.90 = \frac{1.90 - 2.10}{5.0 - 29.0}(Q - 5.0)$$

The vertical distance of any point from this line in terms of cubic centimeters N/20 sodium ethylate required per gram of fat will be

$$D' = S - 1.90 - \left[\frac{1.90 - 2.10}{5.0 - 29.0}(Q - 5.0)\right]$$

Solving this equation, it becomes

$$D' = S - 0.008Q - 1.858$$

If dealing with a sample of unknown quality, the actual values for acidity of the fat and ether extract are substituted for *S* and *Q*, respectively, and the result is interpreted as explained under the ammonia nitrogen plot (p. 63).

REDUCING SUGAR.

As the reducing sugar is a part of the egg solids not fat, it is plotted in figure 3 against the differences between the total solids and the sums of the ether extract, sucrose, and salt, all factors being expressed as percentage on the wet basis. While no determinations of sucrose and salt were made, the amounts alleged to be present by the manufacturers were assumed to be present in those samples containing sucrose or salt.

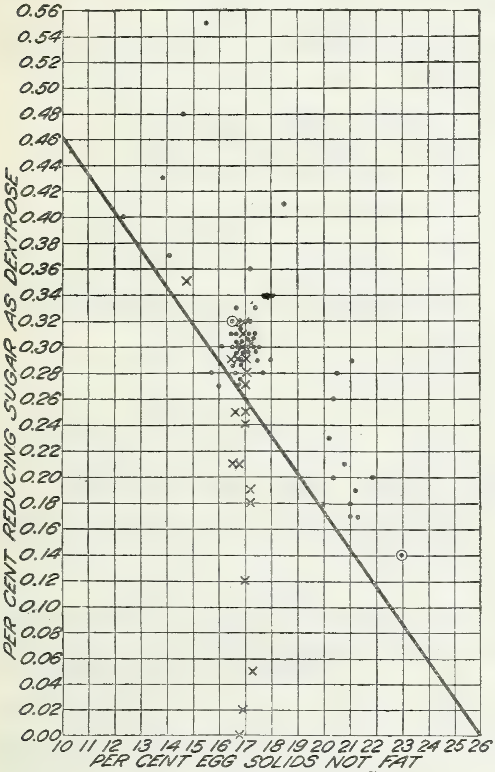

FIG. 3—Reducing sugar results.

As in the other plots, a line has been drawn to separate the dots and crosses. In the case of reducing sugar, where decomposition is accompanied by a decrease instead of an increase, all the dots should be above the line. All are above, except two which are relatively close to the line. It will be noted that eight crosses are above the line, for which fact an interpretation analogous to that given under acidityof the fat (p. 64) is advanced, namely, that in those particular samples the decomposition was not of a fermentation character, but was of a proteolytic or lipolytic nature.

The majority of the dots and crosses for whole egg lie between 16 and 18.5 per cent of egg solids not fat. Within those limits the minimum percentages of reducing sugar, as shown by the line, vary from 0.288 to 0.216. The dots between 20 and 23 per cent of egg solids not fat represent yolk. Within these limits the minimum corresponding amounts of reducing sugar vary from 0.172 to 0.086 per cent. The dots for sugared yolk are very close to 20 per cent of egg solids not fat, and vary between 0.28 and 0.26 per cent of reducing sugar. The equation for the line in this case is:

$$U-U'=\frac{U'-U''}{T'-T''}(T-T')$$

which, on substituting the widely separated values,

$U'=0.46$ $T'=10.0$ $U''=0.0$ $T''=26.0$

becomes

$$U-0.46=\frac{0.46-\ 0.0}{10.0-26.0}(T-10.0)$$

The vertical distance of any point from this line in terms of percentage of reducing sugars will be

$$D''=U-0.46-\left[\frac{0.46-\ 0.0}{10.0\ -26.0}(T-10.0)\right]$$

Solving this equation it becomes

$$D''=U+0.029T-0.748$$

If dealing with a sample of unknown quality, substitute the values found for reducing sugars and egg solids not fat for U and T, respectively, and give the converse interpretation to that explained under the ammonia nitrogen plot (p. 63).

COMPOSITE RESULTS.

In deciding whether or not a frozen egg product is edible and may pass freely into commerce, it is only in extreme cases that dependence can be placed upon the determination of any one constituent. In ordinary cases, all the analytical figures must be considered in their relation to one another. If, therefore, the values of D, D', and D'' (pp. 62, 64, 66) can be grouped into a composite whole, and factors can be added for the bacterial content, for the *B. coli* content, and for the presence of indol or skatol, of mold clumps, and of embryos, and if the proper relative weights can be found for the different factors, a definite, nonvarying basis of interpretation is provided. The relative weights must be such as to insure a final result which will be less than zero for each of the samples in Tables 1 to 23 considered edible, as well as a proper article of commerce by the experts who made them or saw them made, and which will be greater than zero for each of the samples made from inedible raw materials according to the judgment of these same experts.

Consequently, a rather lengthy series of trials has been made, with the purpose of evolving such a composite expression on what is really a bonus and penalty system. It has been impossible to devise a formula which would separate absolutely the two classes of products. By giving the manufacturer the benefit of the doubt in the border-line cases, however, the following formula has been found to serve admirably for white, whole egg, yolky mixtures, and unsugared yolk, prepared from fresh eggs or storage eggs. It applies, of necessity, only to egg material to which no gross addition of foreign material has been made and which can be recognized by the fact that in white, yolk, whole egg, or yolky mixture, the total nitrogen should amount to 12 to 14 per cent of the solids not fat.

$$10.0D+10.0D'-25.0D''+V+\frac{W}{5{,}000{,}000}+\frac{X}{500{,}000}+Y+Z=0$$

or

$$10.0(R-0.205Q-0.5)+10.0(S-0.008Q-1.858)-25.0\ (U+0.029T-0.748)+V+\frac{W}{5{,}000{,}000}+\frac{X}{500{,}000}+Y+Z=0$$

Q = Per cent ether extract, wet basis.
R = Milligrams ammonia nitrogen per 100 grams, wet basis.
S = Acidity of the fat per gram, as cubic centimeters N/20 sodium ethylate required.
T = Per cent egg solids not fat, wet basis.
U = Per cent reducing sugar, as dextrose, wet basis.
V = 5, if indol or skatol present; 0.0, if absent.
W = Number of bacteria per gram, wet basis, developing on plain agar, at 20° C. in 5 days.
X = Number of confirmed *B. coli* per gram, wet basis, producing 10 per cent or over of gas in lactose broth, at 37° C. in 2 days.
Y = 1 for each mold clump found per 30 pounds of egg material.
Z = 0.5 for each embryo found per 30 pounds of egg material.

An explanation of how the values for V, $\frac{W}{5{,}000{,}000}$, $\frac{X}{500{,}000}$, Y, and Z were determined is necessary.

The value of 5 for V, if indol or skatol was found present, was reached by substituting for V different values in the formula until the proper value was found.

The divisor in $\frac{W}{5{,}000{,}000}$ was decided upon by entering on a chart (fig. 4), against the number of bacteria present, a dot if the sample was considered edible, a cross if it was considered inedible, and a dot with a line through it if it was considered of questionable character. It is understood that dividing W by any divisor and adding the result to the formula gives a figure which places a penalty upon the presence of any bacteria. This is as it should be, since theoretically there should be no bacteria present. Practically, it is impossible, unless the aseptic precautions of the bacteriological laboratory are employed, to open eggs without introducing bacteria. Such aseptic precautions can not be followed in a commercial egg-breaking plant. As the magnitude of the divisor determines the magnitude of the penalty to be imposed, it should be fairly large. It was decided to make the divisor 5,000,000, so that a penalty of unity would be placed upon any sample containing

5,000,000 bacteria, with a penalty of more than unity if more than 5,000,000 bacteria were present and vice versa. In the chart (fig. 4) there are 8 dots above the 5,000,000 line and 3 crosses below it. The penalty imposed in the case of samples with dots above this line is not sufficiently great to cause any of them to have a formula value greater than zero. The choice of 5,000,000 is further vindicated by the extensive experiences of three members of the Bureau of Chemistry in examining commercial frozen egg products and by the narrated experiences of a bacteriologist in a commercial egg-breaking plant who stated that in his opinion no frozen egg product should contain more than 5,000,000 bacteria at any season of the year.

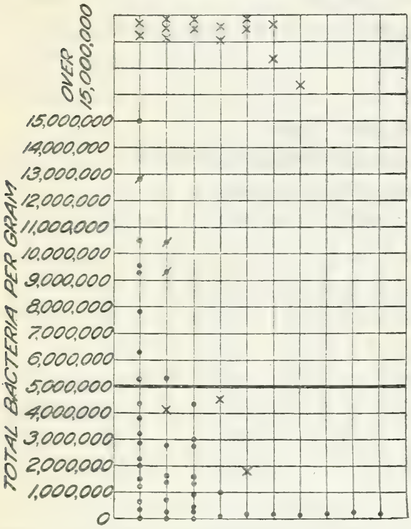

FIG. 4.—Total bacterial counts.

The divisor in $\frac{X}{500,000}$ was determined in a similar manner (fig. 5).

The values assigned to Y and Z are in conformity with what juries and judges have been found to tolerate or condemn in the past, and are also in accord with the 5 per cent bad-egg ruling of the Department of Agriculture.

For sugared yolk, which may be recognized by the fact that the solids not fat will be almost double the ether extract, as compared with approximately equal amounts of these two constituents in the case of unsugared yolk, this formula must be modified to the following form, based upon the plots:

$$10.0\ (R-0.205Q-0.5)+10.0\ (S-0.008Q-1.158)-25.0\ (U+0.029\,T-0.798)+V+\frac{W}{5,000,000}+\frac{X}{500,000}+Y+Z=0$$

It is important to see how these formulas actually work out in practice. At the bottom of Tables 1 to 23 will be found the formula values for the samples, the formula being calculated in each case for the average of the results of the individual analysts. In Tables 1, 2, and 3 the formula values are negative, and of a very appreciable magnitude. In Table 4 the formula value is small, as would be expected in all samples of egg white. In Table 5 all the values are negative, and decrease in magnitude with the length of time the eggs were held in storage. It will be noted that in the first three formula values there are terminal plus signs. These indicate that it probably would have been necessary to make an addition to the formula, if a bacteriological examination had been made. This explanation applies wherever a terminal plus is found in a formula value.

In Table 6 there is a regular progression from a good-sized negative value to a positive value as the length of time in storage increases. That a positive value was obtained for the yolk from eggs held in storage for the longest period of time, while a negative value was found for whole egg made from the same raw material, is somewhat inconsistent. It might be argued that it is fair because the yolk decomposes more readily than the white which is included in the whole egg. On the other hand, however, if the yolk is really decomposed, the whole egg containing it should not be considered edible. The advisability of proposing a separate formula for yolk from storage eggs in order to obtain a negative value for this yolk was considered, but was discarded, because the fewer the formulas the better. Moreover, the present formula gives negative values for the yolk from eggs held in storage for 8 months, and presumably would give similar results for eggs held 10 months, probably the longest period for which eggs used for making frozen yolk would be held. Possibly such raw material might be used for whole egg but not for yolk.

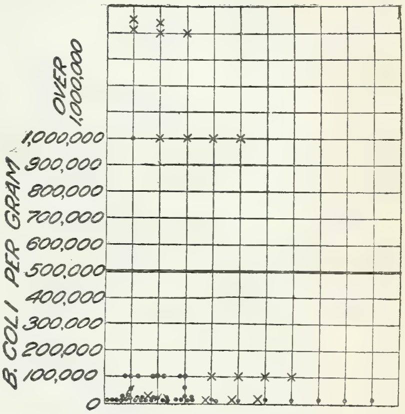

FIG. 5.—*B. coli* counts.

Table 7 shows all white from storage eggs with negative values, or with results so slightly above zero as to be accounted for by analytical errors. Table 8 shows all samples of experimental first-grade whole egg with negative values, even with bacterial contents as high as 10,500,000 per gram. The uniformity of analytical results, and especially of formula values, of these samples prepared from a wide variety of raw materials and in three different factories is noteworthy. The formula values for the commercial first-grade whole egg are given in Table 9. These samples were prepared in the same factories and from the same raw materials as the samples in Table 8 with which they are entirely comparable. It should be noted that all the values are negative, and that the samples were made from August eggs, the poorest eggs of the year.

All the samples of commercial first-grade whole egg containing sugar and salt in Table 10 gave negative formula values, even with bacterial contents as high as 15,000,000 per gram. All the samples of experimental and commercial soft-grade whole egg found in Tables 11 and 12 show negative formula values.

As previously pointed out, an attempt was made by the manufacturers who cooperated in this work and by the Bureau representatives to separate edible breaking stock into two portions, one designated as first grade to be of higher quality than the other designated as soft grade. The formula values for these four groups of samples, as given in Tables 8, 9, 11, and 12, show variations between the following limits, −9.24 to −4.11, −7.12 to −3.17, −7.33 to −4.17, and −9.88 to −1.44, and indicate very strongly that such grading is impossible with breaking stock eggs, as the variation within each group was far greater than was the variation between the different groups. All samples prepared from leakers as given in Table 13 have negative formula values, the one of least magnitude being the one prepared under the most unfavorable conditions. Tables 14, 15, and 16 for yolks show negative formula values, with but small range of magnitude.

This completes the results obtained for samples considered edible by the Bureau representatives who made them or saw them made, and for which the formula values are less than zero. The questionable and inedible samples described in Tables 17 to 23 should show values very close to zero or greater than zero if the formula is reliable.

Table 17 contains the results of analysis of samples of experimental second-grade whole egg. All the formula values are positive, except that for sample 32 which was a low first rather than a second-grade product. The leniency of the formula is shown in Table 18, in which two of the samples of commercial second-grade egg have negative values, even though one of them contained 17,500,000 bacteria per gram. This sample was prepared from April eggs, a fact which helps materially in explaining the chemical figures. It probably represents a low first rather than a second-grade product.

Tables 19 and 20 show high positive values. The formula value for drip given in Table 21 is an index of the character of this product. In Table 22 are collected the results of the examination of samples made from different types of eggs considered inedible unmixed with other eggs. All have positive formula values. Table 23 shows decomposition due to delay in freezing. The progressive change from negative to positive values is interesting. The values for samples 62 and 63 are for badly decomposed material.

SUMMARY OF RESULTS.

To summarize, the formula separates the samples into edible and inedible groups which agree with the classification based upon the known quality of the raw materials from which they were made. If the formula errs in either direction, it is in the direction of leniency.

In order to make comparisons easier, the average results for the different groups of egg products, with the formula values for such averages, have been gathered together in Tables 24 and 25.

TABLE 24.—*Summary of results of examination of eggs considered edible.*

Description of groups of samples.	Total solids (wet basis).	Ether extract (wet basis).	Total solids minus ether extract, sucrose, and salt.	Ammonia nitrogen (wet basis), titration method	Acidity of fat as N/20 sodium ethylate.	Reducing sugar as dextrose (wet basis).	Indol and skatol.	Organisms per gram.					Formula value.
								Plain agar, 20° C., 120 hours.	Plain agar, 37° C., 48 hours.	Acid producers, lactose litmus agar, 37° C., 48 hours.	Alkali producers, lactose litmus agar, 37° C., 48 hours.	Confirmed *B. coli.*	
(1) Experimental whole egg. Prepared in laboratories from best fresh eggs obtainable. (Table 1):	*Per ct.*	*Per ct.*	*Per ct.*	*Mg. per 100 grams.*	*Cc. per gram.*	*Per ct.*							
Average	26.54	10.00	16.54	1.5	1.49	0.32	0	0	0			0	—16.27
Maximum	27.19	11.01	16.65	2.0	1.72	.36	0	0	0			0	
Minimum	25.96	9.31	16.18	1.0	1.21	.29	0	0	0			0	
(2) Commercial whole egg. Freshly prepared from May eggs. (Table 2):													
Average	27.59	10.28	17.31	2.0	1.80			1,500,000	1,000,000				—7.18
Maximum	28.57	11.20	17.37	2.3	1.91			4,400,000	3,700,000				
Minimum	26.78	9.66	17.12	1.6	1.66			70,000	17,000				
(3) Experimental first-grade whole egg. No sugar or salt. (Table 8):													
Average	27.85	10.97	16.88	2.2	1.87	.29	0	4,000,000	1,800,000	230,000	22,000	17,500	—6.20
Maximum	29.05	11.53	17.52	2.4	1.92	.31	0	10,500,000	4,900,000	550,000	100,000	100,000	
Minimum	27.09	10.55	16.54	1.9	1.84	.27	0	120,000	80,000	20,000	0	100	
(4) Commercial first-grade whole egg. No sugar or salt. (Table 9):													
Average	28.24	11.26	16.98	2.5	1.82	.31	0	2,600,000	1,600,000	320,000	90,000	100,000	—5.00
Maximum	28.91	11.78	17.13	2.8	1.95	.32	0	5,300,000	2,900,000	660,000	260,000	550,000	
Minimum	27.29	10.45	16.84	2.3	1.73	.29	0	160,000	25,000	0	0	100	
(5) Commercial first-grade whole egg. 1 per cent sugar, 0.7 per cent salt. (Table 10):													
Average	28.89	10.89	16.30	2.3	1.75	.30	0	6,500,000	2,200,000	850,000	0	220,000	—5.00
Maximum	29.37	11.48	16.67	2.5	1.90	.31	0	15,000,000	5,850,000	850,000	0	1,000,000	
Minimum	27.71	9.91	15.10	1.8	1.67	.28	0	340,000	20,000	850,000	0	100	
(6) Experimental soft-grade whole egg. No sugar or salt. (Table 11):													
Average	27.62	10.93	16.69	2.3	1.83	.30	0	3,600,000	850,000	97,000	3,000	67,000	—5.61
Maximum	27.82	11.22	16.69	2.5	1.84	.32	0	9,300,000	2,300,000	130,000	10,000	100,000	
Minimum	27.26	10.65	16.60	2.1	1.82	.28	0	320,000	110,000	60,000	0	550	
(7) Commercial soft-grade whole egg. No sugar or salt. (Table 12):													
Average	26.81	10.28	16.53	2.3	1.85	.31	0	1,600,000	1,900,000	5,000	0	18,500	—4.65
Maximum	27.35	10.66	16.69	2.4	1.99	.33	0	3,800,000	4,700,000	10,000	0	35,000	
Minimum	25.81	9.83	15.98	2.0	1.73	.27	0	130,000	90,000	0	0	100	

(8) Experimental whole egg. Prepared from leakers. No sugar or salt. (Table 13):													
Average	29.58	12.24	17.34	2.6	1.69	.30	0	8,800,000	1,700,000	53,000	0	50,000	—6.26
Maximum	30.30	12.71	17.59	2.8	1.84	.30	0	12,800,000	2,600,000	100,000	0	100,000	
Minimum	28.68	11.78	16.90	2.2	1.59	.28	0	2,000,000	950,000	5,000	0	100	
(9) Experimental yolk. Prepared in laboratories from best fresh eggs obtainable. (Table 3):													
Average	49.69	26.66	23.03	2.7	1.72	.14	0	0	0				—36.66
Maximum	50.90	28.78	24.01	3.1	1.96	.20	0	0	0				
Minimum	46.93	24.49	22.44	2.5	1.44	.08	0	0	0				
(10) Experimental first-grade yolk. No sugar. (Table 14):													
Average	43.31	23.14	20.17	4.2	1.81	.19	0	260,000	220,000	0	0	550	—13.36
Maximum	43.42	23.25	20.17	4.4	1.81	.20	0	280,000	270,000	0	0	1,000	
Minimum	43.19	23.03	20.16	4.1	1.80	.18	0	240,000	160,000	0	0	100	
(11) Commercial first-grade yolk. No sugar. (Table 15):													
Average	44.19	23.08	21.11	4.1	1.91	.18	0	2,500,000	1,000,000			26,500	—13.19
Maximum	44.84	23.69	21.15	4.2	1.99	.20	0	5,300,000	2,200,000			100,000	
Minimum	43.10	22.18	20.92	4.0	1.84	.17	0	270,000	140,000			100	
(12) Commercial first-grade yolk. 10 per cent sugar. (Table 16):													
Average	48.76	18.35	20.41	3.4	1.13	.27	0	600,000	240,000			5,500	—11.82
Maximum	49.06	18.65	20.52	3.7	1.19	.28	0	950,000	450,000			10,000	
Minimum	48.46	17.94	20.32	3.1	1.04	.26	0	220,000	20,000			1,000	
(13) Experimental white. Prepared in laboratories from best fresh eggs obtainable. (Table 4):													
Average	12.35	.05	12.30	.5		.40	0	0	0				—0.32
Maximum	12.83	.12	12.71	1.2		.46	0	0	0				
Minimum	11.80	.01	11.79	.0		.31	0	0	0				

TABLE 25.—*Summary of results of examination of eggs considered inedible.*

Description of groups of samples.	Total solids (wet basis).	Ether extract (wet basis).	Total solids minus ether extract, sucrose, and salt (wet basis).	Ammonia nitrogen (wet basis), titration method	Acidity of fat as N/20 sodium ethylate.	Reducing sugar as dextrose (wet basis).	Indol and skatol.	Organisms per gram.					Formula value.
								Plain agar, 20° C., 120 hours.	Plain agar, 37° C., 48 hours.	Acid producers, lactose litmus agar, 37° C., 48 hours.	Alkali producers, lactose litmus agar, 37° C., 48 hours.	Confirmed *B. coli.*	
(1) Experimental second-grade whole egg. No sugar or salt (Table 17):	*Percent.*	*Percent.*	*Percent.*	*Mg. per 100 grams.*	*Cc. per gram.*	*Per cent.*							
Average	27.73	10.73	17.00	2.7	1.90	0.31	0	47,500,000	20,900,000	3,300,000	2,300,000	370,000	+ 8.43
Maximum	28.75	11.62	17.13	3.1	1.95	.31	0	105,500,000	53,000,000	8,000,000	2,300,000	1,000,000	
Minimum	26.68	9.79	16.11	2.2	1.82	.30	0	4,100,000	3,800,000	900,000	2,200,000	1,000	
(2) Commercial second-grade whole egg. No sugar or salt (Table 18):													
Average	28.38	11.44	16.94	3.7	1.88	.28	0	76,500,000	14,400,000	3,500,000	200,000	220,000	+23.01
Maximum	29.45	12.44	17.01	4.4	2.22	.32	0	211,000,000	58,000,000	10,000,000	500,000	1,000,000	
Minimum	27.13	10.18	16.95	2.6	1.72	.25	0	380,000	800,000	100,000	0	5,500	
(3) Experimental tanners' grade whole egg. No sugar or salt (Table 19):													
Average	27.59	10.64	16.95	3.0	1.89	.25	+	16,300,000	4,000,000	2,000,000	200,000	100,000	+11.28
Maximum	27.59	10.64	16.95	3.0	1.89	.25	+	16,300,000	4,000,000	2,000,000	200,000	100,000	
Minimum	27.59	10.64	16.95	3.0	1.89	.25	+	16,300,000	4,000,000	2,000,000	200,000	100,000	
(4) Commercial tanners' grade whole egg. No sugar or salt (Table 20):													
Average	27.09	10.38	16.71	6.8	2.24	.21	+	279,300,000	156,000,000	28,000,000	83,000,000	10,000,000	+126.91
Maximum	27.36	10.53	16.83	7.2	2.29	.21	+	360,000,000	211,000,000	28,000,000	83,000,000	10,000,000	
Minimum	26.76	10.20	16.56	6.4	2.18	.21	0	198,500,000	101,000,000	28,000,000	83,000,000	10,000,000	
(5) Commercial drip. No sugar or salt (Table 21)	20.44	5.62	14.82	2.6	1.89	.35	0	63,500,000	20,500,000			1,000,000	+23.25
(6) Experimental whole egg. Prepared from cracked eggs with moldy shells (Table 22)	27.18	10.65	16.53	2.4	1.87	.27	+	4,500,000	900,000	100,000	0	10,000	+ 2.32
(7) Experimental whole egg. Prepared from eggs with slightly stuck yolks (Table 22)	27.86	10.83	17.03	2.8	2.07	.29	0						+ 1.14
(8) Experimental whole egg. Prepared from eggs with slightly disintegrated yolks (border-line rots) (Table 22)	27.71	11.01	16.70	3.1	2.01	.29	0						+ 3.41+
(9) Experimental whole egg. Prepared from eggs which were partially addled (mixed rots) (Table 22)	28.39	11.40	16.99	4.5	2.15	.24	0						+19.02+
(10) Experimental whole egg. Prepared from eggs which were sour (Table 22)	27.79	10.64	17.15	4.5	2.19	.19	0	397,000,000	370,000,000	24,000,000	135,000,000	10,000,000	+121.57+

(11) Experimental whole egg. Prepared from eggs with green whites (Table 22)	27.24	10.02	17.22	4.9	1.87	.18	0	285,000,000	213,500,000	35,000,000	40,000,000	10,000,000	+101.49
(12) Experimental whole egg. Prepared from eggs which were completely addled (white rots) (Table 22)	28.34	11.38	16.96	12.8	3.46	.12	+						+123.18+
(13) Experimental whole egg. Prepared from eggs with heavily stuck yolks (Table 22)	28.38	11.12	17.26	12.8	6.61	.05	+						+156.77+
(14) Experimental decomposing whole egg. Put in freezer after holding for 23 hours at 66° F. (Table 23)	28.59	11.70	16.89	6.7	2.29	.02	0	284,500,000	293,500,000	280,000,000	12,000,000	10,000,000	+126.05
(15) Experimental decomposing whole egg. Put in freezer after holding for 29½ hours at 66° F. (Table 23)	28.14	11.38	16.76	8.2	2.27	.00	0	250,000,000	238,000,000	140,500,000	11,100,000	1,000,000	+115.43

The results presented in Tables 24 and 25 are summarized even more briefly in Table 26.

TABLE 26.—*Limits of variation found.*

Determination.	Whole egg.			
	Freshest obtainable. Opened aseptically. June and July eggs.	Held in cold storage from 4 to 13 months. Opened aseptically. April and May eggs.	Regular breaking stock. Considered edible. Opened commercially. August eggs.	Breaking stock. Considered inedible. Opened commercially. August eggs.
Total solids (per cent)	25.96 to 27.19	27.88 to 29.34	25.81 to 30.30	26.68 to 29.45
Ether extract (per cent)	9.31 to 11.01	10.52 to 10.88	9.66 to 12.71	9.79 to 12.44
Total solids minus ether extract, sucrose, and salt (per cent)	16.18 to 16.65	17.36 to 18.46	15.98 to 18.19	16.11 to 17.26
Ammonia nitrogen (mg. per 100 grams)	1.0 to 2.0	2.6 to 3.2	1.6 to 2.8	2.2 to 12.8
Acidity of fat (cc. N/20 sodium ethylate per gram)	1.21 to 1.72	1.50 to 1.83	1.59 to 1.99	1.72 to 6.61
Reducing sugar (per cent)	0.29 to 0.36	0.31 to 0.41	0.27 to 0.33	0.00 to 0.31
Bacteria, 20° C., 5 days	0.0 to 0.0	0.0 to 0.0	70,000 to 15,000,000	380,000 to 397,000,000
Acid producers, 37° C., 2 days	....	....	0.0 to 850,000	100,000 to 280,000,000
Alkali producers, 37° C., 2 days	....	....	0.0 to 260,000	0.0 to 135,000,000
B. coli, 37° C., 2 days	0.0 to 0.0	....	100 to 1,000,000	1,000 to 10,000,000

Determination.	Yolk.		
	Freshest obtainable. Opened aseptically. June and July eggs.	Held in cold storage from 4 to 13 months. Opened aseptically. April and May eggs.	Regular breaking stock. Considered edible. Opened commercially. August eggs.
Total solids (per cent)	46.93 to 50.90	39.43 to 43.87	43.10 to 44.84
Ether extract (per cent)	24.49 to 28.78	19.24 to 22.74	22.18 to 23.69
Total solids minus ether extract, sucrose, and salt (per cent)	22.44 to 24.01	20.19 to 21.13	20.16 to 21.15
Ammonia nitrogen (mg. per 100 grams)	2.5 to 3.1	3.8 to 6.4	4.0 to 4.4
Acidity of fat (cc. N/20 sodium ethylate per gram)	1.44 to 1.96	1.53 to 1.82	1.80 to 1.99
Reducing sugar (per cent)	0.08 to 0.20	0.18 to 0.29	0.17 to 0.20
Bacteria, 20° C., 5 days	0.0 to 0.0	0.0 to 87,000	240,000 to 5,300,000
Acid producers, 37° C., 2 days	....	....	0.0 to 0.0
Alkali producers, 37° C., 2 days	....	....	0.0 to 0.0
B. coli, 37° C., 2 days	....	0.0 to 0.0	100 to 100,000

Determination.	Sugared yolk.	White.	
	Regular breaking stock. Considered edible. Opened commercially. August eggs.	Freshest obtainable. Opened aseptically. June and July eggs.	Held in cold storage from 4 to 13 months. Opened aseptically. April and May eggs.
Total solids (per cent)	48.46 to 49.06	11.80 to 12.83	13.96 to 15.54
Ether extract (per cent)	17.94 to 18.65	0.01 to 0.12	0.03 to 0.07
Total solids minus ether extract, sucrose, and salt (per cent)	20.32 to 20.52	11.79 to 12.71	13.92 to 15.51
Ammonia nitrogen (mg. per 100 grams)	3.1 to 3.7	0.0 to 1.2	0.4 to 0.8
Acidity of fat (cc. N/20 sodium ethylate per gram)	1.04 to 1.19	....	....
Reducing sugar (per cent)	0.26 to 0.28	0.31 to 0.46	0.37 to 0.55
Bacteria, 20° C., 5 days	220,000 to 950,000	0.0 to 0.0	0.0 to 110,000
Acid producers, 37° C., 2 days	....	....	....
Alkali producers, 37° C., 2 days	....	....	....
B. coli, 37° C., 2 days	1,000 to 10,000	....	0.0 to 0.0

METHODS OF EXAMINATION OF SAMPLES.

METHODS TESTED.

In the course of the preliminary preparation and examination of samples in the laboratories numerous questions arose concerning the details of the analytical methods. During the examination of samples prepared in egg-breaking plants, and subsequently, experiments were performed to settle these questions, a short discussion of which would seem proper at this place, to save the time of chemists who, not knowing that such experiments had already been made, might again cover the same ground.

USE OF SAND IN THE DETERMINATION OF TOTAL SOLIDS.

One of the analysts who tried this procedure in his preliminary work reported that he considered the use of sand an improvement, in that the drying period was generally shortened, the final results being the same with sand and without, in the case of whole egg. With yolk, the results were invariably found to be higher when no sand was used, presumably due to incomplete drying. With white, the results were reported as inconclusive. It was noted that due to other demands on the suction pump, the average vacuum was only 22 inches, which is believed to be the explanation for the difficulty with yolk.

TABLE 27.—*Percentage of total solids obtained when sample is dried with and without sand.*

Sample No.	Whole egg.			
	Dried with 10 grams sand in 3-inch lead dish.		Dried without sand in 3-inch lead dish.	
	A.	B.	A.	B.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
3972	26.98	26.86	27.00	27.01
3973	26.04	26.14	26.12	26.26
3974	26.27	26.12	26.35	26.39
3975	26.61	26.75	26.80	26.78
4476	26.52	26.45	26.56	26.56
Average	26.47		26.58	

Sample No.	Yolk.				White.			
	Dried with 5–10 grams sand in 3-inch lead dish.		Dried without sand in 3-inch lead dish.		Dried with 5–10 grams sand in 3-inch lead dish.		Dried without sand in 3-inch lead dish.	
	A.	B.	A.	B.	A.	B.	A.	B.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
4477	50.49	50.46	50.78	50.76	12.78	12.93	12.78	Lost
4478	50.82	50.90	50.99	50.91	12.35	12.29	12.36	12.36
4479	50.52	50.58	50.79	50.79	12.79	12.85	12.82	12.83
4480	50.13	49.90	50.51	50.42	12.04	12.04	12.26	12.22
4481	50.51	50.45	50.81	51.03	12.56	12.53	12.83	12.85
Average	50.48		50.78		12.52		12.60	

In the opinion of the chemists who finally passed upon the methods, the slight differences in results do not warrant the extra labor connected with the use of sand.

AMOUNT OF SAMPLE TO BE USED FOR TOTAL SOLIDS DETERMINATION.

The reason for investigating this matter was connected primarily with the determinations of ether extract and of acidity of the fat which it was considered might be made more accurate by using larger amounts of sample. The question then arose as to whether these larger amounts of sample could be completely dried to give correct total solids. The results obtained are given in Table 28.

TABLE 28.—*Percentage of total solids obtained with varying amounts of sample.*

Sample No.	Initial of analyst.	Using 2.5± grams.		Using 5.0± grams.	
		A.	B.	A.	B.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
16	B	27.59	27.68	27.63	27.68
	D	27.57	27.71	27.13	27.12
	E	27.32	27.17	27.16	27.21
	H	26.73	30.04	26.86	28.90
	S	27.72	27.50	27.32	27.42
18	B	29.58	29.77	29.60	29.61
	D	31.77	30.34	29.75	29.83
	E	29.06	28.86	28.92	28.88
	H	29.09	28.69	28.45	28.73
	S	29.97	30.41	29.90	30.02
1	D	30.36	29.92	29.83	29.99
	E	31.27	30.66	30.69	30.84
	H	30.32	30.35	30.44	30.33
	S	29.46	29.51	28.55	29.94
3	D	29.24	29.38	28.75	28.82
	E	29.12	29.23	29.06	28.99
	H	28.53	28.23	28.41	28.31
	S	29.00	28.81	28.44	28.65
15	D	21.22	21.05	20.88	20.84
	E	19.58	19.47	19.61	19.44
	H	20.55	20.40	20.01	20.37
	S	21.57	21.79	21.55	21.63
Average		27.58		27.31	

There is not much difference in the results obtained by the two methods, but what little difference there is indicates the desirability of using the larger amount, as it gives more uniform results, presumably due to decrease in the percentage error.

Determination of Ether Extract from the Solids Dried With and Without Sand.

The analyst who proposed the use of sand in the determination of solids noted that sand had no effect on the amount of ether extract obtained from whole egg or yolk, and did not seem to accelerate the extraction. The figures which he obtained are given in Table 29.

Table 29.—*Percentage of ether extract obtained when sample is dried with and without sand.*

Sample No.	From solids with sand.		From solids without sand.		Sample No.	From solids with sand.		From solids without sand.	
	A.	B.	A.	B.		A.	B.	A.	B.
Whole egg:	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	Yolk:	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
3972	10.24	10.13	10.23	10.15	4477	28.81	28.89	28.70	28.71
3973	9.32	9.42	9.38	9.39	4478	28.12	28.27	28.07	28.07
3974	9.97	9.64	9.68	9.71	4479	27.37	27.51	27.48	27.29
3975	9.97	10.03	10.04	10.07	4480	27.20	27.12	Lost	27.06
4476	9.95	9.90	9.93	9.90	4481	27.36	27.43	27.35	27.57
Average	9.86		9.85		Average	27.81		27.81	

Effect upon Ether Extract Determination of the Amount of Sample Used for Total Solids Determination.

The difference is so small as to show that either amount may be used, with a slight preference for the larger amount because of greater uniformity (Table 30).

Table 30.—*Percentage of ether extract obtained with varying amounts of the sample.*

Sample No.	Initial of analyst.	Using 2.5± grams.		Using 5.0± grams.	
		A.	B.	A.	B.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
16	B	10.64	10.74	10.72	10.70
	D	10.54	10.46	10.46	10.51
	E	10.51	10.30	10.52	10.41
	H	10.31	10.13	10.44	10.17
	S	10.60	10.70	10.52	10.46
18	B	11.16	11.18	11.15	11.22
	D	11.56	12.78	11.58	11.46
	H	10.88	10.64	9.89	10.81
	S	11.33	11.33	11.14	11.18
1	D	12.36	12.44	12.47	12.45
	E	13.12	12.65	12.85	12.84
	H	13.00	12.60	12.63	12.82
	S	11.63	11.97	12.90	12.11
3	D	11.76	11.71	11.75	11.54
	E	11.57	11.50	11.50	11.47
	H	11.34	11.55	11.46	11.42
	S	11.57	11.42	12.41	11.32
15	D	6.07	5.83	5.84	5.67
	H	5.59	5.59	5.59	5.42
	S	5.94	5.91	5.90	5.88
	Average	10.57		10.53	

KNORR APPARATUS VS. JOHNSON APPARATUS FOR ETHER EXTRACT DETERMINATION.

As many food laboratories are equipped with the Johnson apparatus but not with the Knorr apparatus, which has almost invariably been recommended for egg work, a comparison of results using the two was made, extracting in all cases for 3 hours.

TABLE 31.—*Percentage of ether extract obtained by using Knorr apparatus and Johnson apparatus.*

Sample No.	Initial of analyst.	Knorr.		Johnson.	
		Using 2.5± grams.	Using 5.0± grams.	Using 2.5± grams.	Using 5.0± grams.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
16	B	10.64	10.72	10.74	10.70
	D	10.54	10.46	10.46	10.51
	E	10.51	10.52	10.30	10.41
	H	10.31	10.44	10.13	10.17
	S	10.60	10.52	10.70	10.46
18	B	11.16	11.15	11.18	11.22
	D	11.56	11.58	12.78	11.46
	H	10.88	9.89	10.64	10.81
	S	11.33	11.14	11.33	11.18
1	D	12.36	12.47	12.44	12.45
	E	13.12	12.85	12.65	12.84
	H	13.00	12.63	12.60	12.82
	S	11.63	12.90	11.97	12.11
3	D	11.76	11.75	11.71	11.54
	E	11.57	11.50	11.50	11.47
	H	11.34	11.46	11.55	11.42
	S	11.57	12.41	11.42	11.32
15	D	6.07	5.84	5.83	5.67
	H	5.59	5.59	5.59	5.42
	S	5.94	5.90	5.91	5.88
	Average	10.57		10.53	

It is evident that the Johnson apparatus may be substituted for the Knorr apparatus, although the Knorr should always be used if possible.

EFFECT OF TIME OF EXTRACTION UPON THE ETHER EXTRACT DETERMINATION.

Nothing is gained by prolonging the extraction for more than 3 hours, as is shown by the results given in Table 32.

TABLE 32.—*Percentage of ether extract obtained during varying periods of extraction.*

Sample No.	Extracted 3 hours.	Extracted 16 hours.
	Per cent.	*Per cent.*
3972	10.24	10.40
	10.13	10.22
	10.23	10.32
	10.15	10.22
Av.	10.19	10.29

DETERMINATION OF ACIDITY OF FAT FROM THE SOLIDS DRIED WITH AND WITHOUT SAND.

Obviously the acidity of the fat is not affected by the presence or absence of sand (Table 33).

TABLE 33.—*Acidity of fat obtained when sample is dried with and without sand.*

Sample No.	From solids with sand.		From solids without sand.	
	A.	B.	A.	B.
	Cc. N/20 sodium ethylate per gram.	*Cc. N/20 sodium ethylate per gram.*	*Cc. N/20 sodium ethylate per gram.*	*Cc. N/20 sodium ethylate per gram.*
Whole egg:				
3972	1.36	1.54	1.36	1.50
3973	1.32	1.22	1.26	1.30
3974	1.43	1.40	1.36	1.38
3975	1.29	1.26	1.38	1.37
4476	1.52	1.46	1.59	1.59
Average	1.38		1.41	
Yolk:				
4477	1.77	1.81	1.75	1.83
4478	1.77	1.73	1.74	1.79
4479	1.66	1.68	1.71	1.70
4480	1.69	1.62	Lost	1.80
4481	1.55	1.53	1.65	1.64
Average	1.68		1.73	

EFFECT UPON ACIDITY OF THE FAT DETERMINATION OF AMOUNT OF SAMPLE USED.

The results are in favor of the larger amount, as shown by Table 34.

TABLE 34.—*Acidity of fat obtained with varying amounts of sample.*

Sample No.	Initial of analyst.	Using 2.5± grams.		Using 5.0± grams.	
		A.	B.	A.	B.
		Cc. N/20 sodium ethylate per gram.	*Cc. N/20 sodium ethylate per gram.*	*Cc. N/20 sodium ethylate per gram.*	*Cc. N/20 sodium ethylate per gram.*
16	B	2.09	2.21	2.15	2.22
	D	2.39	1.91	2.08	2.09
	E	2.39	1.91	2.08	1.91
	H	2.61	2.48	2.33	2.19
	S	2.22	2.07	2.17	2.11
18	B	2.09	1.88	1.69	1.67
	D	2.59	2.21	1.80	1.89
	H	2.30	2.06	2.19	1.78
	S	2.21	2.03	1.95	1.97
1	D	2.70	2.54	2.27	1.88
	E	1.85	1.55	1.50	1.52
	H	1.93	1.63	2.09	1.65
	S	1.95	1.92	1.69	1.74
3	D	2.91	2.43	2.21	1.93
	E	1.72	1.74	1.51	1.52
	H	2.13	1.52	2.05	1.70
	S	1.71	1.74	1.67	1.63
15	D	4.48	2.78	3.34	2.47
	H	2.71	2.35	2.71	1.90
	S	1.81	1.79	1.94	1.81
	Average	2.21		1.98	

EFFECT UPON THE ACIDITY OF THE FAT DETERMINATION OF USING THE KNORR OR JOHNSON APPARATUS.

Table 35 shows the effect upon the acidity of the fat determination of using the Knorr apparatus and Johnson apparatus.

TABLE 35.—*Acidity of fat obtained by using the Knorr apparatus or Johnson apparatus.*

Sample No.	Initial of analyst.	Knorr.		Johnson.	
		Using 2.5± grams.	Using 5.0± grams.	Using 2.5± grams.	Using 5.0± grams.
		Cc. N/20 sodium ethylate per gram.	*Cc. N/20 sodium ethylate per gram.*	*Cc. N/20 sodium ethylate per gram.*	*Cc. N/20 sodium ethylate per gram.*
16	B	2.09	2.15	2.21	2.22
	D	2.95	2.18	2.13	2.09
	E	2.39	2.08	1.91	1.91
	H	2.61	2.33	2.48	2.19
	S	2.22	2.17	2.07	2.11
18	B	2.09	1.69	1.88	1.67
	D	2.59	1.80	2.21	1.89
	H	2.30	2.19	2.06	1.78
	S	2.21	1.95	2.03	1.97
1	D	2.70	2.27	2.54	1.88
	E	1.85	1.50	1.55	1.52
	H	1.93	2.09	1.63	1.65
	S	1.95	1.69	1.92	1.74
3	D	2.91	2.21	2.43	1.93
	E	1.72	1.51	1.74	1.52
	H	2.13	2.05	1.52	1.70
	S	1.71	1.67	1.74	1.63
15	D	4.48	3.34	2.78	2.47
	H	2.71	2.71	2.35	1.90
	S	1.81	1.94	1.79	1.81
	Average	2.22		1.96	

USE OF DUBOSCQ AND SCHREINER COLORIMETERS IN THE NESSLERIZATION METHOD FOR AMMONIA NITROGEN.

As many food laboratories are equipped with Schreiner colorimeters and not with Duboscq instruments which have always been recommended for this work, a series of comparative tests was made with the two instruments, using the same solutions in both instruments. The results are given in Table 36.

Table 36.—*Ammonia nitrogen obtained by use of Duboscq and Schreiner colorimeters in the nesslerization method.*

Sample No.	Initial of analyst.	Ammonia nitrogen.			Sample No.	Initial of analyst.	Ammonia nitrogen.		
		Duboscq.	Schreiner.	Titration.			Duboscq.	Schreiner.	Titration.
		Mg. per 100 grams.	*Mg. per 100 grams.*	*Mg. per 100 grams.*			*Mg. per 100 grams.*	*Mg. per 100 grams.*	*Mg. per 100 grams.*
45	B	1.5	1.2	2.0	66	H	1.8	1.4	2.9
46	B	1.6	1.3	1.9		S	3.0	2.8	3.1
47	B	1.9	1.5	2.2	67	E	2.0	2.0	2.1
48	B	2.1	1.8	2.8		H	2.3	2.5	2.5
51	B	4.6	3.9	4.5		S	2.4	2.2	2.2
60	D	3.1	2.7	3.0	76	E	2.3	2.3	2.4
	E	2.3	2.2	2.6		H	2.7	2.1	2.9
	H	2.6	1.8	3.0		S	2.7	2.3	2.8
61	D	2.9	2.4	2.8	77	E	7.0	6.8	7.5
	E	2.4	2.5	2.6		H	8.0	6.6	6.6
	H	3.0	2.4	3.0		S	8.2	8.5	8.1
62	D	6.3	6.0	6.9	68	E	6.5	6.1	4.2
	E	6.1	6.7	6.5		H	3.7	2.8	4.9
	H	6.5	5.9	6.8		S	5.5	5.3	4.5
63	D	9.9	8.2	7.6	69	E	6.5	6.7	4.4
	E	7.0	8.0	8.0		H	4.5	4.5	5.0
	H	7.8	8.2	8.7		S	5.7	4.9	4.7
74	D	2.3	2.1	2.6	70	E	2.2	2.1	2.1
	E	2.1	2.2	2.4		H	2.4	1.5	2.1
	H	2.0	1.4	2.7		S	2.9	2.4	2.4
75	D	2.1	2.0	2.8	71	E	2.5	2.4	2.1
	E	2.1	2.0	2.9		H	2.4	1.8	2.5
	H	2.3	1.5	2.3		S	2.4	2.1	2.4
64	E	2.4	2.4	2.2	72	E	2.7	2.7	2.5
	H	2.3	2.1	2.3		H	4.5	3.1	2.8
	S	2.4	2.0	2.8		S	2.7	2.3	2.8
65	E	2.4	2.3	2.3	73	E	3.3	3.2	2.7
	H	1.9	1.6	2.8		H	2.0	1.4	3.2
	S	2.8	2.3	2.6		S	3.0	3.6	3.1
66	E	2.7	2.7	3.0					

From Table 36 it is evident that the Schreiner instrument may not be substituted for the Duboscq colorimeter, since it gives results which are in the majority of cases decidedly lower than those obtained with the Duboscq instrument. By comparing the nesslerization results with the titration results, it will be seen that the results with the Duboscq colorimeter are too low and that the results with the Schreiner, which are still lower, are decidedly inaccurate.

Nesslerization Method for Ammonia Nitrogen.

Dissatisfaction with the nesslerization method for the determination of ammonia nitrogen was expressed by the chemists throughout the cooperative work, not only because of the lack of uniformity of results, but also because of mechanical difficulties in the method. Much trouble was experienced with foaming. At first this was overcome to a large extent by adding a few cubic centimeters of amyl alcohol, but this method has the disadvantage that the amyl alcohol, due to its volatility, often must be added more than once during the aeration, and also it has a tendency to give a slight blank reading. Later very heavy cylinder oil was used successfully to prevent foaming. Recently one of the analysts reported in connection with some determinations made on samples subsequent to the cooperative work that the nesslerization method caused difficulty, although the reagents used were the same as those which had given satisfactory results a few months before. He considers the method too uncertain on account of the foaming and sometimes also turbidity to meet with general approval.

The consensus of opinion of those who participated in the work here reported is that while the nesslerization method for ammonia nitrogen in frozen-egg products may, because of the shorter time which it consumes, be of value, it is not nearly as accurate as the titration method, which is preferable where absolutely dependable results are required, as, for example, in analyses where court action may be involved. If the nesslerization method is used for this purpose it should be run in triplicate and the average result employed.

STRENGTH OF ALUMINA CREAM TO BE USED IN THE REDUCING SUGAR DETERMINATION.

During the course of the work the question arose as to whether, if alumina cream was kept in a large container and was not always shaken to a homogeneous mixture before a portion was removed for use, the results would be affected by the use of cream of varying concentrations. To decide this, alumina cream of regular strength was prepared, and it was used as such and also after dilution with varying amounts of water. The results are shown in Table 37.

TABLE 37.—*Reducing sugar obtained with alumina cream of varying strengths.*

Initial of analyst.	100 cc. alumina cream, 0 cc. water.	75 cc. alumina cream, 25 cc. water.	50 cc. alumina cream, 50 cc. water.	25 cc. alumina cream, 75 cc. water.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
B	0.31	0.30	0.30	0.29
B	.31	.30	.31	.32
D	.38	.36	.37	.37
D	.36	.36	.38	.36
E	.33	....	.32	....
E	.16	....	.18	....
E	.43	....	.44	....
H	.35	.36	.34	.35
S	.32	.33	.34	.32

These tabulated results prove conclusively that the concentration of the alumina cream has no influence.

CHOICE BETWEEN SULPHURIC AND HYDROCHLORIC ACIDS IN THE DETECTION OF INDOL AND SKATOL.

Experiments proved that sulphuric acid is preferable, because it gives more distinct colorations.

METHODS ADOPTED.

Frozen Eggs.

TAKING OF SAMPLES.

When possible, frozen egg samples consist of original unopened packages, comprising representative containers of the product in any individual shipment. Take enough containers to represent fairly a whole shipment, and send all samples to the laboratories in the quickest possible way. When transported by common carriers, pack the samples so as to prevent thawing, and take every precaution to prevent delay in transit. Deliver the samples to the bacteriologist immediately upon arrival at the laboratory, and examine no sample which does not arrive in a frozen condition. If the material is slightly melted around the circumference, the subsamples for bacteriological and chemical examination must be withdrawn from the portion which is still frozen.

When samples are opened, the bacteriologist, chemist, and microscopist all are present, and, in case of official samples, they initial and date seals and cans for identification in the regular manner. To preclude all possibility of a claim of contamination during sampling, the bacteriologist withdraws subsamples first when a container is opened. The chemist then withdraws subsamples, and the remainder is turned over to the microscopist. Each analyst gives a receipt to the one from whom the container is received in the case of official samples.

SUBSAMPLES FOR BACTERIOLOGICAL EXAMINATION.

Take subsamples for bacteriological examination by means of sterilized utensils, and place them in sterile containers, which are then immediately placed on ice. Take two subsamples of at least 100 grams each from every can of egg material, one for immediate examination, and one to be placed as quickly as possible in cold storage at approximately 0° F., for a later check examination, if necessary.

For withdrawing subsamples it will be found convenient to use a sterile butter sampler long enough to insure the removal of a core of frozen material from the top to the bottom of the container, after the surface layer of the frozen material has been removed with a sterilized instrument (chisel). If the sample is frozen very solid it may be found necessary to use a brace and long-shanked bit or shipbuilder's auger, and to collect the shavings for the sample. Cores should be taken midway between the center and circumference, from at least three widely separated parts of the container, to form a composite sample.

Thoroughly sterilize the butter sampler or bit before use by flaming over a Bunsen burner or alcohol lamp, after immersion in alcohol.

If it is necessary to use a spoon to collect the chips made by a bit, it should be sterilized in like manner. Wipe all utensils thoroughly clean with a cloth before each sterilization. Thoroughly cleansed Mason jars, which have been sterilized in the autoclave with the rubber rings and covers in place, make convenient containers for subsamples.

The bacteriologist records the general condition of all samples at the time of sampling, specifying the temperature, appearance, color, and odor.

SUBSAMPLES FOR CHEMICAL EXAMINATION.

The two chemical subsamples are taken in the same way as the bacteriological subsamples, except that sterile instruments and containers need not be used, and at least 1 pound of material is collected for each subsample. One of these should be placed in cold storage immediately at approximately 0° F.

SUBSAMPLES FOR PHYSICAL AND MICROSCOPICAL EXAMINATION.

These consist of the entire contents of each container, after the bacteriological and chemical subsamples have been removed.

Liquid Egg.

Thoroughly mix liquid egg samples with a sterilized utensil, such as a long-handled dipper which has been immersed, including the handle, in alcohol and flamed, after which subsamples are withdrawn for examination. Place the subsamples for bacteriological examination in sterilized containers. Keep a record of the general condition at the time of sampling, specifying the temperature, appearance, color, and odor.

Shell Eggs.[1]

WHOLE EGG.

Clean each egg[2] with brush, soap, and water, and immerse for 10 minutes in a 1:500 mercuric chlorid solution. Transfer with sterile crucible tongs to a small conical graduate or other convenient holder, acute pole uppermost. Remove the mercuric chlorid and dry the egg by pouring over it first alcohol and then ether. Scorch the acute pole to kill spores that may remain. Immediately remove the egg from the graduate, holding it near the blunt pole, turning the acute pole down. The hands of the operator should have been thoroughly greased with vaseline to avoid contamination by bacteria that might rub off during the handling of the eggs. Hold the egg over the sterile container[1] which is to receive its contents, and with sharp, stout forceps, which have been sterilized in the flame, make a hole of sufficient size to allow the contents of the egg to drop into the container. Contamination from above is prevented by holding the egg with the acute pole down and making the stab from below.

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[1] These methods are included because they were used in the preparation and examination of samples in the laboratories.

[2] Adaptation of method of Bushnell and Maurer, Kansas Agr. Coll. Bul. 201.

In this manner introduce the contents of the desired number of eggs into the container. Then thoroughly mix these eggs with a sterilized electric stirrer, like those used at soda fountains to mix eggs.

SEPARATED YOLK AND WHITE.

Clean each egg with brush, soap, and water, and immerse for 10 minutes in 1:500 mercuric chlorid solution. Transfer with sterile crucible tongs to a small conical graduate or other convenient holder, acute pole uppermost. Remove the mercuric chlorid, and dry the egg by pouring over it first alcohol and then ether. Scorch the acute pole to kill spores that might remain. Immediately remove the egg from the graduate, holding it near the blunt pole and turning the acute pole down. The hands of the operator should have been thoroughly greased with vaseline to avoid contamination by bacteria that might rub off during the handling of the eggs. With sharp, stout forceps which have been sterilized in the flame, make a hole about ½ centimeter in diameter in the acute pole. Contamination from above is prevented by holding the egg with the acute pole down and making the stab from below. Flame briskly the shell around the hole and put the egg, with the acute pole down, upon the flamed neck of a sterilized Erlenmeyer flask. Now heat the blunt end of the egg with a Bunsen flame, keeping a close watch on the hole. The heating expands the air in the air space, which expels the white of the egg. As soon as the yolk appears in the hole, interrupt the heating and tilt the egg from one side to the other to allow all of the albumen to run out. Then hold the egg over another sterilized container, and with a sterile platinum needle puncture the vitelline membrane.

In this way collect the whites of the desired number of eggs in one container and the yolks in another. Finally thoroughly mix the whites with a sterile electric stirrer. The yolks are treated in like manner.

BACTERIOLOGICAL EXAMINATION.

Start the bacteriological examination immediately after the taking of subsamples, all determinations being made on the gram basis. After melting a subsample by partially immersing the container in water at 40° C., thoroughly mix the material with a sterilized electric stirrer of the type commonly used at soda fountains for mixing eggs. One with a detachable plunger, which can be removed, dipped in alcohol and flamed, is best. Examine this mixed composite sample by the following methods:

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[1] A thoroughly cleaned Mason jar which has been sterilized in the autoclave with rubber ring and cover in place makes a good container.

ENUMERATION OF VIABLE BACTERIA.

Into a tared, sterile, glass-stoppered Erlenmeyer flask of 60 to 100 cc. capacity, weigh approximately 5 grams of the mixed composite sample to the nearest hundredth of a gram, and dilute with 9 cc. of sterile physiological salt solution (0. 85 per cent sodium chlorid) for each gram of egg. Add about 2 grams of sterile glass beads or broken glass. Shake thoroughly until the mixture is homogeneous. Further dilutions are made in the regular way by transferring 1.0 cc. of the mixture to 9 cc. or 99 cc. dilution bottles of sterile physiological salt solution in the customary manner. From the appropriate dilutions prepare a series of plates with standard nutrient agar for counting after incubation at not less than 19° C. or more than 21° C. for 5 days. Perform all of these operations in duplicate.

No count of bacteria is official unless based upon duplicate plates which agree closely and have between 30 and 300 colonies upon them when counted with a lens magnifying 3½ diameters, or what opticians call a three and one-half X lens. In case it is doubtful whether certain objects are colonies or dirt specks, examine them with a compound microscope.

ENUMERATION OF B. COLI.

Inoculate lactose broth fermentation tubes, in duplicate, with appropriate dilutions of the sample, and make a quantitative determination of the presence of members of the *B. coli* group.[1]

ENUMERATION OF TOTAL BACTERIA.

In a tared clean flask of about 50 cc. capacity, weigh approximately 5 grams of the well-mixed sample to the nearest hundredth of a gram, and dilute with twice the amount of physiological salt solution. Add sterile glass beads or broken glass, and mix thoroughly till homogeneous. Transfer a 0.01 cc. portion of this mixture to a microscopic slide by means of a capillary pipette of such bore that 0.01 cc. occupies from 1.2 to 2 centimeters, and the tip of which pipette has been ground to a truncated cone. Lay the slide on a piece of black paper upon which a square, 2 centimeters to a side, has been ruled with white ink. By means of a heavy platinum needle, bent into the shape of a hockey stick, spread the liquid evenly over the square within the white lines. A drop of distilled water may be added, if necessary, to obtain an even distribution. Dry in the air on a level surface. Make three such slides from each subsample.

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[1] Standard Methods of Water Analysis of the American Public Health Association.

Immerse the slides carrying the dried egg films in xylol or benzol for 1 minute. Again dry, and place in 1 per cent carbolic methylene blue for from 10 to 20 minutes. The object is to stain the bacteria deeply, and to stain fat, débris, and background as lightly as possible. To do this, wash off the excess of stain in water, and immerse in 50 to 60 per cent alcohol until only a faint blue is visible. This decolorizing is quickly done. Failure to decolorize is followed by serious errors in results.

Dry, and examine with the microscope, counting 20 fields along the diagonals of each slide.

A desirable optical combination to employ is that which is used in the direct microscopic examination of milk. The microscope should have an oil immersion objective and an ocular giving the field desired, and should be fitted with a mechanical stage. To standardize the microscope, place upon the stage a stage micrometer, and on the diaphragm of the ocular place an eyepiece micrometer, with a circular ruling, 8 mm. in diameter, and divided into quadrants. Adjust the draw tube until the inner circle of the eyepiece micrometer has a diameter of 0.146 mm. Record the necessary adjustment of the draw tube. By this adjustment, the inner circle will cover 1/7,200,000 cc. of the undiluted egg, giving a factor of 7,200,000. This means that the number of bacteria in a single field should be multiplied by 7,200,000, or, if 60 fields are counted, the total number should be multiplied by 120,000, to obtain the number of bacteria in 1 cc. of the original egg material. If any variation from this procedure is used, the factor must be calculated.

CHEMICAL EXAMINATION.[1]

Start the chemical examination immediately after the taking of subsamples, and make all determinations in duplicate. Thaw the subsamples by partially immersing the containers in warm water, the temperature of which should not be above 50° C. Then thoroughly mix them, preferably with an electric stirrer. In the absence of such an instrument in the laboratory, the mixing may be quite satisfactorily accomplished by sucking the melted subsample several times through a Gooch crucible containing no asbestos, using very moderate suction. Examine this mixed composite sample by the following methods:

TOTAL SOLIDS.

Weigh approximately 5 grams of the sample into a tared lead dish of 2½ to 3 inches diameter, and dry in a vacuum of not less than 25 inches at 55° C., until there is no further loss in weight. This drying usually requires about 4 hours. It is recommended that weighings be made at the end of 3½ hours of drying, and thereafter at intervals of about 30 minutes. Weigh to three decimal places. There is an appreciable gain in weight after the minimum has been reached. Express the results as per cent on the wet basis.

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[1] The analytical methods described were very largely devised or adapted to egg analysis by N. Hendrickson, formerly of the Food Research Laboratory.

ETHER EXTRACT.

Extract the dry residue from the determination of solids with absolute ether, preferably in a Knorr apparatus, but if this is not available, in a Johnson extractor. Cut through the sides of the lead dish containing the solids at four equidistant points. Place the dish upon a fat-free filter paper. Flatten down the sides of the dish. Place another fat-free filter paper on top of the flattened dish, and roll the papers and dish into a cylinder which will fit the extraction tube fairly snugly. In making the cylinder, turn in the ends in such a way as to prevent solid particles from dropping into the extraction flask. Place the cylinder in the extraction tube without any asbestos plug below it. If the extractor is working rapidly, three hours is sufficient to insure a proper extraction.

Distill off the ether from the extraction flask, and dry the extract for one hour at 55° C., in a vacuum of not less than 25 inches. Weigh to three decimal places. Express the results as per cent on the wet basis.

The ether used should not contain any alcohol or water, as a higher result is obtained when either is present. It is, therefore, understood that ether freshly distilled from sodium will be used.

ACIDITY OF THE FAT.

Dissolve the fat obtained in the determination of ether extract in 50 cc. of neutral benzol to which has been added 2 drops of phenolphthalein indicator. Titrate with N/20 sodium ethylate. Express the results as the number of cubic centimeters of N/20 sodium ethylate required to neutralize 1 gram of fat.

AMMONIA NITROGEN.

The titration method is an adaptation of Folin's method for the determination of ammonia in urine.[1] It consists essentially in making the sample alkaline, removing the liberated ammonia by aeration, and catching it in a measured quantity of standardized acid. The excess acid is then titrated.

The apparatus consists of the following: (1) A wash bottle containing dilute sulphuric acid (about 35 per cent) to remove any ammonia that may be present in the air entering the system. (2) Some form of trap to prevent sulphuric acid being carried over mechanically. (3) An aerating cylinder about 50 mm. in diameter and 350 mm.

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[1] Zeit. physiol. Chem. (1902), 37: 161.

high, fitted with a 2-hole rubber stopper carrying a right-angle air-inlet tube, open at the bottom and extending to within ½ inch of the bottom of the cylinder, and a trap containing either a cotton or glass wool plug to prevent any liquid from being carried over mechanically. (4) A wide-mouthed 8-ounce bottle fitted with a delivery tube coming from the trap on the aerating cylinder. It is not essential that the special ammonia absorption tubes be used. An ordinary glass tube with a small bulb blown on the end through which a few holes are punctured answers very well. The method of making these is given by Folin and Farmer.[1] (5) A means of passing air through the system. This is best done by a pump which will furnish a blast with a pressure of 10 pounds per square inch and which discharges into a tank of sufficient size to compensate for the pulsations of the pump and to deliver a steady blast. Suction may be used, but it is not recommended. Each of the first four parts enumerated is fitted with a 2-hole rubber stopper, and all are connected by glass tubes of suitable shape and length to permit the proper passage of air through the apparatus. The tube leading into the acid wash bottle should contain a stop cock for regulating the air supply.

Weigh approximately 25 grams of sample in a convenient container. Pour as much as possible of this material into the aeration cylinder, and transfer the remainder by means of four 25 cc. portions of ammonia-free water, stirring each time with a rubber-tipped glass rod to remove any egg adhering to the sides of the weighing vessel. Add 75 cc. of alcohol, mix well, let stand for 15 minutes. Add approximately 1 gram of sodium fluorid, 2 cc. of 50 per cent potassium carbonate solution, and 1 cc. of kerosene. Connect the apparatus, and aerate into the receiving bottle, which should contain 10 cc. of N/50 sulphuric acid, 2 drops of methyl red indicator (saturated solution in 95 per cent alcohol), and about 75 cc. of ammonia-free water. The aeration should be carried on for 4 hours, or as long as necessary to remove all of the ammonia, using as rapid a current of air as possible. Titrate the excess of acid with N/50 sodium hydroxid (free from carbon dioxid). Express the results obtained as milligrams of ammonia nitrogen per 100 grams of sample on the wet basis. If there is insufficient time to complete the determination, the sample may be left over night in the cylinder with the alcohol and sodium fluorid added. The potassium carbonate, of course, should not be added until ready to proceed. If the sample has a bad odor it may be necessary to use more than 10 cc. of N/50 sulphuric acid.

It is essential that a blank experiment be run to determine the percentage recovery of ammonia, using a known amount of pure ammonium sulphate[1] (containing about 3 mg. of nitrogen) and 25 cc. of water, instead of the egg. The recovery should be over 95 per cent. It is also essential to run blank experiments with the reagents and water used.

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[1] J. Biol. Chem. (1912), 11: 496.

The nesslerization method is an adaptation of the micro-method of Folin and Macallum for the determination of ammonia in urine.[2] The essential features of the method consist of rendering a small sample alkaline, removing the liberated ammonia by aeration, and catching it in dilute sulphuric acid. This is then nesslerized, and the ammonia determined quantitatively by comparing the intensity of the color with a known standard in a Duboscq colorimeter.

The apparatus employed is as follows: (1) An ordinary acid bottle, fitted with a 2-hole rubber stopper, and containing from 200 to 300 cc. of 35 per cent sulphuric acid, to serve as a wash bottle for removing any ammonia that may be present in the air which passes through the system. (2) A 10 by 1⅛ inch test tube of strong glass connected to the wash bottle, to serve as a trap to remove any spray of dilute acid. (3) A small Kjeldahl flask of about 125 cc. capacity for holding the sample. (4) A 10 by 1⅛ inch test tube, to serve as a trap to catch any foam which may be formed in the sample and carried over mechanically. (5) A 100 cc. volumetric sugar flask containing 2 cc. of approximately N/20 sulphuric acid and about 20 cc. of ammonia-free water. (6) A means of passing air through the system, like that described for the titration method (p. 91). Blast at 10 pounds pressure is preferred; suction may be used. Each of the first five parts enumerated is fitted with a 2-hole rubber stopper, and all are connected by glass tubes of suitable shape and length to permit the proper passage of air through the apparatus. The tube leading into the acid wash bottle should contain a stop cock for regulating the air supply. It is essential that the tube leading into the 100 cc. graduated flask receiving the volatile ammonia be bulb-shaped on the end and perforated with small holes to insure thorough dispersion.

Weigh approximately 3 grams of sample on a watch glass and add a few drops of water at a time, mixing into a homogeneous mass with a rubber-tipped glass rod, until about 3 cc. of water have been added. Then wash into the Kjeldahl flask with about 10 cc. of ammonia-free water. Add 6 cc. of a solution containing 10 per cent of sodium carbonate and 15 per cent of potassium oxalate. Add enough very heavy cylinder oil to make a layer over the liquid. Pass through this mixture a current of air of sufficient strength to cause a slight spray in the receiving flask, which contains about 20 cc. of ammonia-free water made acid with 2 cc. of approximately N/20 sulphuric acid. Aerate for 1 hour and dilute the liquid in the flask nearly to the 100 cc. mark with ammonia-free water. Add 2 cc. of Nessler solution, fill the flask to the mark with ammonia-free water. Close the flask with a thoroughly washed rubber stopper, and shake well. Compare the color in a Duboscq colorimeter [1] with that of a known standard made up at the same time, and containing 2 cc. of approximately N/20 sulphuric acid. Express the results as milligrams of ammonia nitrogen per 100 grams of sample on the wet basis.

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[1] For method of preparing pure ammonium sulphate, see Folin and Farmer, J. Biol. Chem. (1912), 11: 496.

[2] J. Biol. Chem. (1912), 11: 523.

It is essential that a blank experiment be run, using a known amount of pure ammonium sulphate (containing about 0.3 mg. of nitrogen) and 25 cc. of ammonia-free water, instead of the egg material. Such an experiment should show over 95 per cent recovery. It is also essential to run blank experiments with the reagents and water used.

This method while more rapid is not as accurate as the titration method. If it is employed for samples where legal action may be involved, it should be run in triplicate, and the average of the three determinations used.

Phosphotungstic acid method.—Weigh 5 grams of well-mixed sample in a tared 100 cc. glass-stoppered Erlenmeyer flask. Add 45 cc. of phosphotungstic acid solution made up as follows: Water, 420 cc.; 1 per cent sulphuric acid, 10 cc.; 20 per cent phosphotungstic acid, 20 cc. Shake well. Let stand 5 minutes, and filter through a folded ammonia-free filter paper. Transfer to an aeration cylinder 10 cc. of filtrate, which corresponds to 1 gram of sample; add 2 drops of white petroleum oil, and 1 cc. of 10 per cent solution of sodium carbonate. Aerate strongly for ½ hour into 3 cc. of 1 per cent sulphuric acid. The same chain of apparatus as that described for the nesslerization method (p. 92) should be used. Nesslerize with 0.25 cc. of a Nessler solution made with mercuric iodid, dilute to 10 cc. with ammonia-free water, and compare with a standard prepared with 0.03 mg. of nitrogen in the form of ammonium sulphate in 10 cc. volume.

If a heavy red precipitate forms on adding Nessler solution, add just enough 5 per cent acetic acid to dissolve it, dilute to about 45 cc., again add Nessler solution, and make up to 50 cc. Make the necessary change in the calculation for the greater dilution. Express the results as milligrams of ammonia nitrogen per 100 grams of sample on the wet basis.

This method is good for rapid and approximately accurate work, but should not be used for samples where legal action may be involved.

REDUCING SUGAR.

Wash 25 grams of sample into a 200 cc. graduated flask with 75 cc. of water. Make slightly acid by adding 2 cc. of 5 per cent acetic acid for white or whole egg and 1 cc. for yolk. Mix, and immerse the flask in boiling water until the egg material is thoroughly coagulated. This requires about 15 minutes. Cool to room temperature, and make up to the mark with washed alumina cream. The sample is then shaken vigorously for 1 minute, is allowed to stand about 5 minutes, and then shaken for 1 minute. Filter through a dry folded filter, and determine the reducing sugar in 50 cc. of the filtrate by the Munson and Walker method. Calculate as dextrose, and express the results as per cent on the wet basis.

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[1] The Schreiner instrument gives results which are too low.

The washed alumina cream is prepared by washing ordinary alumina cream five times by decantation, using enough water so that at least half of the total volume may be syphoned off each time.

On account of the volume occupied by the precipitate the results are a trifle high. This error amounts to about 1.4 per cent for white, 3.3 per cent for whole egg, and 7 per cent for yolk. It is not customary to correct for this.

INDOL AND SKATOL.

Dilute a 200 cc. portion of sample with 500 cc. of water, acidified with 40 cc. of 5 per cent acetic acid for white or whole egg, and with 20 cc. for yolk, coagulate in boiling water or live steam, and filter. Steam distill the filtrate as rapidly as possible. Extract the distillate (approximately 300 cc.) with ether in a separatory funnel. To the ether extract add about 3 cc. of water, and evaporate before an electric fan until the smell of ether has almost but not entirely disappeared. A trace of ether does not affect the result. Add 10 cc. of water, filter, and apply the vanillin test to the filtrate.

Vanillin test.—To 5 cc. of the solution to be tested add 5 drops of a 5 per cent solution of vanillin in 95 per cent alcohol and concentrated sulphuric acid. The acid should be added in the proportion of 2 cc. for each 5 cc. of solution being tested. If indol is present, an orange color, soluble in chloroform, amyl acetate, or amyl valerianate, will be formed. If skatol is present, a deep red to violet color, readily soluble in chloroform, amyl acetate, or amyl valerianate, will be formed.[1]

As confirmatory tests, if needed, the following are suggested:

P-Dimethylaminobenzaldehyde test.—To the solution to be tested add 1 cc. of a solution consisting of 4 parts of para-dimethylaminobenzaldehyde, 380 parts of absolute alcohol, and 80 parts of concentrated hydrochloric acid, in such a way as to form two liquid layers.[2] If indol is present a purplish red color will be formed.

Dimethylaniline test.—To 5 cc. of the test solution add 5 drops of dimethylaniline and 4 cc. of concentrated sulphuric acid. If skatol is present, a deep red violet coloration is formed.[3]

PRESERVATIVES.

Formaldehyde.—The test may be made exactly as in milk.[4]

Boric acid.—Make the test as in milk.[5]

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[1] J. Biol. Chem. (1916), 24: 528.

[2] Zeit. physiol. chem. (1906), 42: 25.

[3] J. Biol. Chem. (1916), 24: 527.

[4] Leach, Food Inspection and Analysis, 3d ed., page 268.

[5] Leach, Food Inspection and Analysis, 3d ed., page 182.

Salicylic acid.—Use the method for the detection of salicylic acid in preserved eggs.[1]

MISCELLANEOUS CHEMICAL TESTS.

The chemical tests described are those which up to the present time have been found most useful in detecting the presence of decomposed egg material. With advances in knowledge it is probable that these will be supplemented and possibly displaced by new and even better methods. The following methods, upon which some work has already been done, seem to offer possibilities:

Inorganic phosphoric acid.—R. M. Chapin and W. C. Powick have discussed "An Improved Method for the Estimation of Inorganic Phosphoric Acid in Certain Tissues and Food Products," in the Journal of Biological Chemistry (1915), volume 20, number 2, page 97.

Separation and quantitative determination of the lower alkylamines in the presence of ammonia.—A method for this separation and determination has been published by F. C. Weber and J. B. Wilson in the Journal of Biological Chemistry (1918), volume 35, number 2, page 385.

Catalase.—Tests for this determination are discussed by Rullman in Centralblatt für Bakteriologie, Parasitenkunde und Infectionskrankheiten. II Albteilung (1915), volume 45, page 219, and by M. E. Pennington and H. C. Robertson, jr., in U. S. Department of Agriculture, Bureau of Chemistry Circular 104.

Determination of degree of putrefaction.—F. W. Foreman and G. S. Graham-Smith have reported their method in the Journal of Hygiene (1917), volume 16, page 109.

PHYSICAL AND MICROSCOPICAL EXAMINATION.

Note the odor of frozen egg products while the product is frozen and again after thawing. For this purpose remove a small amount from the can and immediately thaw it. Allow the remainder of the contents of the can to thaw in running cold water, which takes about 12 hours for a 30-pound can. Examine the sample for mold, embryos, eggshells, dirt, larvæ, and other foreign material by the following methods:

PHYSICAL.

Note the odor of the eggs. Good eggs have a characteristic eggy odor, which must be distinguished from a sour, a musty, and a rotten odor of bad eggs. Then make a physical examination to detect the presence of mold, embryos, eggshells, dirt, larvæ, and any foreign material, as follows:

Dip out a small amount into a large, flat pan, the one most satisfactory being white enamel, 2 inches deep and measuring 12 by 17 inches. Add enough water to the egg to make a thin mixture, about one-half inch deep; separate any masses present by the fingers or forceps until the whole is a homogeneous mixture. By tilting the pan back and forth any thickened portions or black specks can be detected. These thickened portions of albumen and yolk, which may or may not be discolored, generally contain mold. Remove any suspicious pieces, and examine microscopically. If embryos are present they can be detected by a dark spot, which is the pigment in the eye. After carefully examining a panful in this manner, strain it through a sieve, usually one of the ordinary household type, 12 inches in diameter, with about 1½ mm. mesh (or 16 or 20 meshes to the inch). Wash through the sieve all of the egg which will go through easily without rubbing. Search what remains on the sieve for mold, embryos, dirt, etc. The entire sample should be examined in this manner. Express results as number of each per 30 pounds of material.

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[1] Chem. Abs. (1914), 8: 3331.

MICROSCOPICAL.

Any pieces picked out of the egg as being suspicious must be examined microscopically. If mold is present this examination will show the mycelium, which may be colorless or dark. Often spores are present. To detect the mycelium it is necessary to make a thin mount through which the light readily passes. The lighting must be carefully adjusted, however, as the mycelium is generally about the color of the egg. This requires only a small amount of each piece. The remainder, as well as the embryos and foreign material, should be preserved in 5 per cent formalin for court exhibit. It is unnecessary to make a microscopical examination for embryos, as those found are usually of from three to five days' development. At this age they are well formed and easily recognized macroscopically.

The analyst must become familiar with the appearance of various kinds of inedible eggs. This can easily be accomplished by obtaining rejects from a candling establishment and breaking them out. The spot eggs found in frozen eggs are heavy spots where the yolk is thickened and of a whitish appearance, or moldy spots, or spot eggs containing embryos. White rots can not be determined by this examination, as they are too intimately mixed with the whole mass.

SUMMARY.

Analytical results for eggs of the same quality agree very closely, no matter whether the eggs are produced and examined in Washington, Philadelphia, New York, Chicago, or San Francisco. When carefully followed, the analytical methods described in this bulletin will give concordant results in the hands of a number of analysts. A formula has been devised which will separate into edible and inedible groups samples of liquid or frozen white, whole egg, yolky mixture, and yolk prepared from either fresh eggs or storage eggs. A formula for sugared yolk is also proposed.

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